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ORIGINAL MEMOIRS.

THE PROPHYLAXIS OF CANCER.*

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ALL vertebrate animals suffer from cancer in situations which are affected by their habits or conditions of life leading to local lesions in the protective mechanism. We must, therefore, look upon local lesions as an invitation to cancer without regard to just what the actual cause of cancer may be.

If parasitic agencies are the cause of cancer it would appear that their introduction into the human economy was affected through local lesions. The strongest evidence as to the parasitic nature of cancer and the best research on the problem with which I am acquainted is the work on the production of plant cancer by Erwin Smith,¹ which agrees in its main essentials with what we know about cancer as it exists in the human race.

On the other hand, if the cancerous process is one which is brought about by failure to restore normal conditions at the site of a local lesion by means of mature cells and the eventual calling forth of partially differentiated cells of an embryonic type in response to continued irritation, the rôle of the local lesion in either case is as important as is the actual cause.

It is probable that a large majority of human beings possess an immunity to cancer, that a lesser number possess

* The President's Address before the American Surgical Association, April 9, 1914.

a partial immunity, while a minority are without those protective agencies which render the local lesion ineffective. The term "precancerous," while not strictly accurate, has become allowable through custom and graphically describes a clinical condition, as pointed out by Rodman.²

The clinician can say with a great deal of assurance that a certain lesion is benign, that another is malignant, but there still exists a number of mid-ground lesions of which he is unable to say that they are either benign or malignant.

The pathologist, by microscopic examination, can, in a much higher percentage of cases, definitely establish the benignity or malignancy of a growth. But, there occur certain growths which, even upon minute investigation, he will be unable to diagnose positively as benign or malignant. Sections from such growths sent to different pathologists may bring back contradictory opinions, the majority being undecided.

The microscopic picture which exists in these cases shows a change in character of the cells quite different from the normal but as yet showing no invasion of the surrounding tissues.³ This invasion is held by most pathologists to be essential in establishing malignancy. Pathologists, however, are striving to establish criteria whereby the change in the character of the cells may be shown to indicate malignancy before invasion takes place. Such microscopic appearance is found in the periphery of malignant growths and in chronic lesions which have been known to later develop malignancy. *The term "precancerous," therefore, strictly should not be applied to all local lesions which may be followed by cancer, but only to those local lesions in which cellular changes are taking place that surpass the normal attempt at repair of the lesion itself, but which are not as yet infiltrating surrounding tissue, the local lesion acting as the invitation, the precancerous stage as its probable acceptance.*

Sites of local irritation may be divided into three general groups:

(1) *Congenital or acquired neoplasms, such as moles, warts, and benign tumors of various sorts which may undergo*

malignancy. Keen,⁴ in 1904, called attention to the danger of degeneration of local lesions of this character and presented most interesting and instructive data in regard to their relation to cancer. Bloodgood,⁵ in recent years, in a series of remarkable papers on the cancer problem, points out that of 820 pathologically fully developed cancers of the skin and visible mucous membranes, he was unable to find a single case with a well-taken history which showed the absence of a previous defect which might be looked upon as a precancerous lesion.

(2) *Trauma.* Coley⁶ calls attention to the influence of trauma not only in the development of sarcoma, which has been an accepted fact for a generation, but also to the fact that trauma has a strong influence in the production of carcinoma. Coley made an analysis of 250 cases of carcinoma which came under his personal observation and the histories of which were taken by himself. There was a history of antecedent trauma in 32.8 per cent. of the cases. The influence of trauma in the production of cancer has also been pointed out by McWilliams,⁷ von Bergmann,⁸ Röpke,⁹ Murphy,¹⁰ Ziegler,¹¹ Löwenthal,¹² Liebe,¹³ von Graefe,¹⁴ and others.

(3) *Chronic irritation*, whether the result of mechanical, chemical, or infectious agencies, is the most important of all those precancerous conditions with which we are acquainted and it is undoubtedly the most potent influence in the development of the disease following congenital lesions and trauma. It is to be noted that cancer in any part of the body which is open to inspection may be shown, in practically every instance, to be preceded by a local lesion. The following well-attested examples may be cited: The development of cancer in the mouth from betel-nut irritation; the cancer of the groin in the chimney sweeps and sailors; the development of cancer following the chemical irritation caused by tar, paraffin, petroleum, arsenic, and aniline products; the development of cancer in local lesions produced by heat, as cancer of the lip from smoking; the "kangri" sores following burns; those cancers on the

shins of locomotive drivers who have been exposed for years to the direct action of heat; cancers following chronic irritation due to different forms of radiant energy, X-ray, etc.; cancers following the local lesions due to infections, such as Bilharzia of the bladder, treponema pallidum in keratosis linguæ;¹⁵ nematodes in testicular tumors in horses¹⁶ and in gastric cancer of rats;¹⁷ and, rarely, the development of cancer in the glands of the neck as a result of the combined chemical and infective irritation of tuberculous cervical adenitis.¹⁸

A study of some particular forms of cancer which occur in great frequency as the result of a particular form of chronic irritation is most instructive. An interesting instance is the "horn-core" cancer of cattle, due to the irritation of the ropes through the horns with which the cattle pull their loads.¹⁹ Even more extraordinary is the kangri-burn cancer either on the abdomen, thigh, or vicinity, due to the hot kangri fire-baskets which the natives of Kashmir wear on the lower abdomen under the clothing in cold weather. Neve²⁰ states that from 1890 to 1899, 2020 natives with tumors were operated on at the Kashmir Mission Hospital. Of these tumors, 496 were epithelial cancers, of which 363 were kangri-burn cancers. Equally striking is the betel-nut cancer of the mouth as seen in India. Neblock²¹ states that of 976 carcinomas treated in the Madras General Hospital from 1892 to 1901, 411 or nearly 50 per cent. were located in the mouth. Cancer of the lip is rarely seen except in smokers. Cancer of the groin is practically confined to the chimney sweep and the sailor.

Can we doubt that if the kangri fire-basket were not worn by the natives of Kashmir that this strictly localized form of cancer would not exist? If the betel-nut were not used, the enormous preponderance of cancer of the mouth would not exist in India.

The prophylaxis of cancer on the visible portions of the body includes: the avoidance of all those habits and customs which have been shown capable of producing conditions favorable to the development of malignant disease; the removal

of all congenital or acquired local lesions such as Keen and Bloodgood have shown to be prolific forerunners of malignant degeneration; and the careful observation of patients for early evidences of malignant change following trauma.

Can our knowledge of the development of external cancer be applied to the solution of the problems of the development of internal cancer? Admitting that the mass of evidence as to the rôle of chronic irritation in its various forms and types is the most important factor in the development of cancer in the parts of the body which are exposed to the eye, must we not conclude that cancer on the inner surfaces of the body depends on the same precancerous conditions? It is difficult to develop evidence as to the early appearance of cancer on the internal mucous surfaces of the body because in the early stage there are, as a rule, no manifestations which lead to a visual examination. Yet we have seen a very considerable number of such early cases and we have observed no instances of early cancer in the mucous membrane of the inner surfaces of the body which did not show the presence of a previous local lesion.

In nearly all the cases of cancer of the gall-bladder which we have had an opportunity to carefully examine, gall-stones were either present or there was evidence to show that they had been present (Fig. 1).²²

One is impressed with the collateral evidence that the incidence of gall-stones and cancer of the gall-bladder shows the same increased frequency in the female over the male. Can we doubt that early removal of gall-stones might prevent cancer of the gall-bladder? The mortality of an early operation for gall-stones, other things being equal, is less than $\frac{1}{2}$ per cent. Cancer of the gall-bladder occurred in nearly three per cent. of all the cases of cholelithiasis which came to operation in our clinic. We have had no permanent cures after cholecystectomy for cancer of the gall-bladder which had been diagnosed as cancer previous to operation. A number of cures have followed the removal of early cancer incidental to the removal of thick-walled functionless gall-bladders, thus

showing that it is not the nature or situation of the malignant process but the delay in diagnosis which is so fatal.

Cancer of the stomach forms nearly one-third of all the cancers of the human body. So far as I know this is not true of the lower animals, nor of uncivilized man. Trustworthy evidence on this point is for obvious reasons difficult to obtain. Why is there this extraordinary frequency of cancer of the stomach? Is the stomach a trap and the cancer parasite, if it be a parasite, strained out in the stomach? If that were true, why should not cancer of the stomach be as frequent in the lower animals as in man? In rats, cancer of the stomach is exceedingly common when the animals feed on cockroaches infested with nematodes, which cause a chronic irritation of the rat's gastric mucosa.¹⁷ Under other conditions it is very rare in these animals.

Whenever cancer is found with great frequency in certain situations or in only one class of individuals, it appears to depend on a single cause; this is probably true of gastric cancer. Is it not possible, therefore, that there is something in the habits of civilized man, in the cooking or other preparation of his food, which acts to produce the precancerous lesion? And it is probable that there is just one cause since, if there were many causes, gastric cancer in man would have no such preponderance. Numerous factors would cause the development of cancer in other races and species equally exposed to their action. If we could but know what peculiar agency was responsible for the extraordinary frequency of cancer of the stomach, the knowledge would play a great part in the prophylaxis of cancer.

Has the question of the acidity of the stomach anything to do with the problem? The frequency of cancer in the stomach and in the large intestine, where the secretions are acid, and the absence of cancer in the small intestine, where the secretions are alkaline, is a remarkable fact. Yet this acidity of the stomach is not confined to man, but, so far as I know, the extraordinary frequency of cancer of the stomach is confined to man and to civilized man. Further investigation is needed to elucidate this most interesting problem and a possible source of infor-

mation may lie in a comparative examination of the anatomy, physiology, and pathology and, especially, of the habits of those races of man and those lower animals in whom cancer of the stomach is rare.

Among the precancerous lesions of the stomach, ulcer is the most common. Yet it is a curious fact that ulcer of the duodenum is three times as frequent as of the stomach, though cancer of the duodenum is rare. True it is, however, that ulcer or some other lesion in the stomach, which is of sufficient gravity to produce symptoms not necessarily of ulcer, but symptoms of chronic irritation, existed in more than half of all those cases of cancer of the stomach in which we have been able to make a resection and in a high percentage of these an ulcer was found pathologically^{23, 24} (Figs. 2 and 3). Some pathologists believe that these ulcers are carcinomatous from the beginning. If so, then the base of the ulcer should be carcinomatous (Fig. 4), but in our cases there was no cancer in the base of the ulcer; it was the overhanging margin of the ulcer which showed the cancer (Figs. 5 and 6). It is evident that precancerous lesions exist in the stomach and that these lesions, while possibly not always ulcer, give clinical evidence of their presence in the precancerous stage in at least fifty per cent. of the cases in which the history is taken with this point in view. The extraordinary muscular activity of the stomach in the condition known as pylorospasm, which may result from gall-stones, duodenal ulcer, fecal stones in the appendix, or intestinal lesions, may account for the chronic gastric irritation in some cases. It is even possible that through the influence of this great muscular contraction cells may be loosened and even forced into the underlying tissue.

The prophylaxis of cancer of the stomach consists not only in the removal of gastric ulcers, but also in the relief of all those conditions which cause gastric irritation resulting in the symptom inadequately and possibly incorrectly described as pylorospasm.

Cancer of the small intestine is extremely rare. In a series of 1882 cancers of the gastro-intestinal canal operated on in our clinic (October 1, 1897 to November 1, 1913) only 22

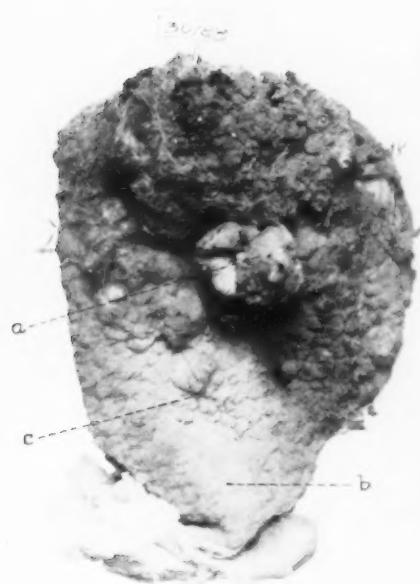
were cancers of the small intestine. Why is there this relative immunity of the small intestine over the stomach and the large intestine? The small intestines are the most primitive part of that system on which the maintenance of the body-functions depend. Is it possible that in the long heredity of this particular part it has developed an immunity? There is something fascinating about this theory as accounting for the lack of immunity in the stomach and the large intestine, which have relatively a short heredity. The small intestine is exceedingly primitive. That the age of any part of the body has much to do with its ability to resist disease is well known. Though it may be a figure of speech that woman was formed from the rib of man, yet it is certainly true that the ovary is descended from the testicle and that the testicle is the primitive organ found in bisexual species.²⁵ Tumors of the testicle are rare. As shown by Ewing,²⁶ all the new growths of the testicle with few exceptions are teratomas, the most primitive type of neoplasm. The ovary, on account of its short heredity, is subjected to a multitude of diseases and a large variety of tumors.

Beard's²⁷ theory that the immunity of the small intestine is due to the pancreatic secretion destroying whatever malignant virus may exist therein may also be mentioned. It is interesting to note, however, that the small intestines have comparatively few sources of chronic irritation and that when malignant disease of the small intestine is found it is usually due to a pre-existing lesion, such as a degenerating polyp, adenoma, or papilloma (Fig. 7).

Cancer of the appendix usually occurs in association with chronic obliterative processes²⁸ (Fig. 8).

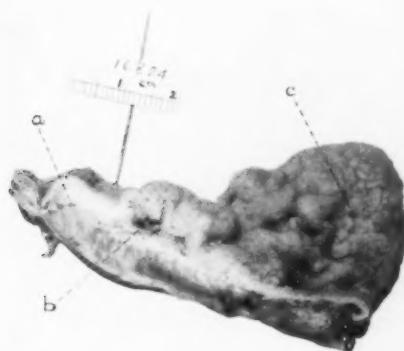
The large intestine has a much greater liability to malignant disease than the small intestine and the frequency with which cancer is found to be grafted on a source of chronic irritation can only lead to the conclusion that the soil produced by chronic irritation needs only to be activated by the cancerous virus to produce cancer in susceptible individuals. The rule is that the original lesion, by the time operation is made, has been completely obscured by the carcinomatous process,

FIG. 1.



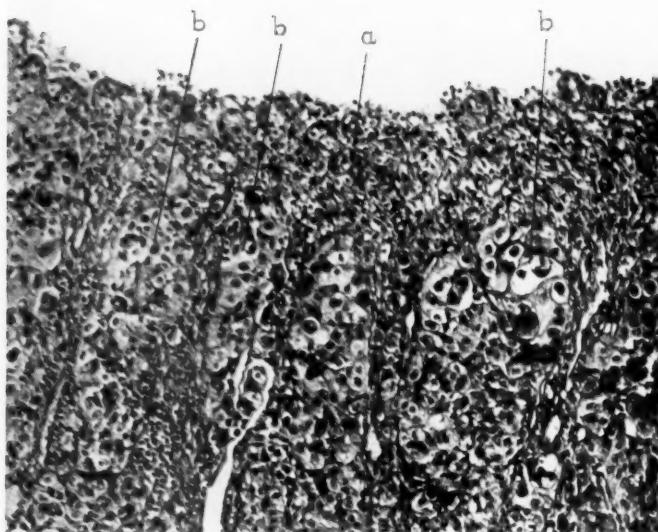
Case 23026G (H30188). Gross specimen, cancer of gall-bladder developing in mucosa long irritated by gall-stones. *a*, cancer; *b*, normal mucosa; *c*, area in which mucosa has been eroded by gall-stones, non-cancerous.

FIG. 2.



Case 5705G (H16824). Gross section through cancer of the pylorus; one of the very few cases in our series which did not show evidence of ulcer. *a*, pylorus; *b*, cancer; *c*, normal gastric mucosa.

FIG. 3.



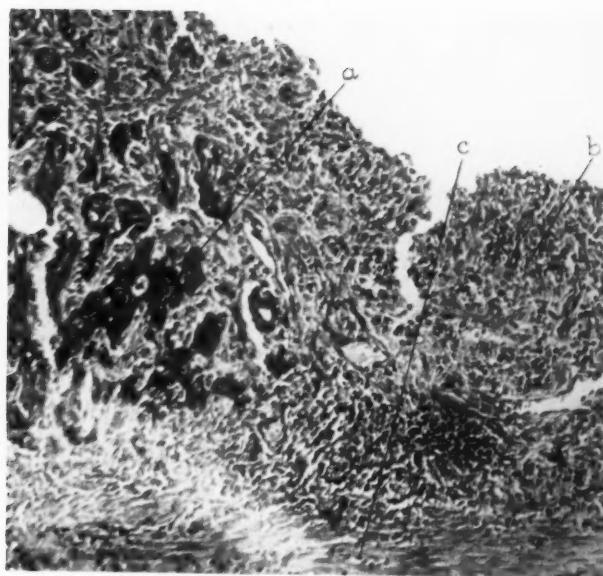
Case 80107. Microscopic section through base of ulcerated portion of gastric cancer. *a*, granulation tissue; *b*, cancer cells. In this specimen there is no pathologic evidence of ulcer preceding the cancer.

FIG. 4.



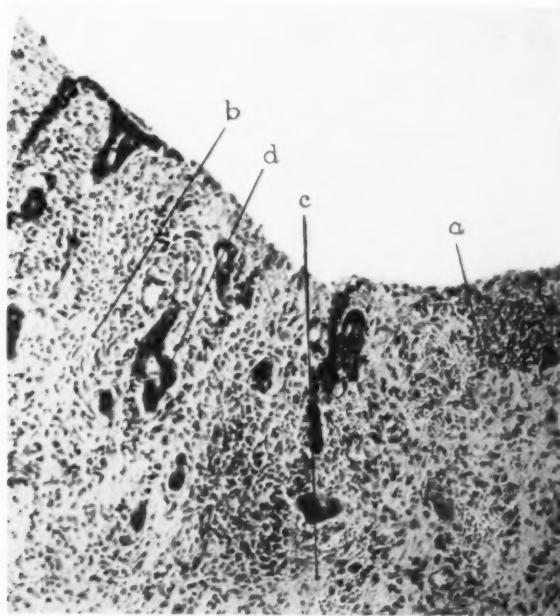
Case 6838G (H18088). Pyloric portion of stomach with multiple ulcers, two of which show areas of cancer within their borders. *a*, pylorus; *b*, chronic ulcers; *c*, ulcers with cancer developing thereon.

FIG. 5.



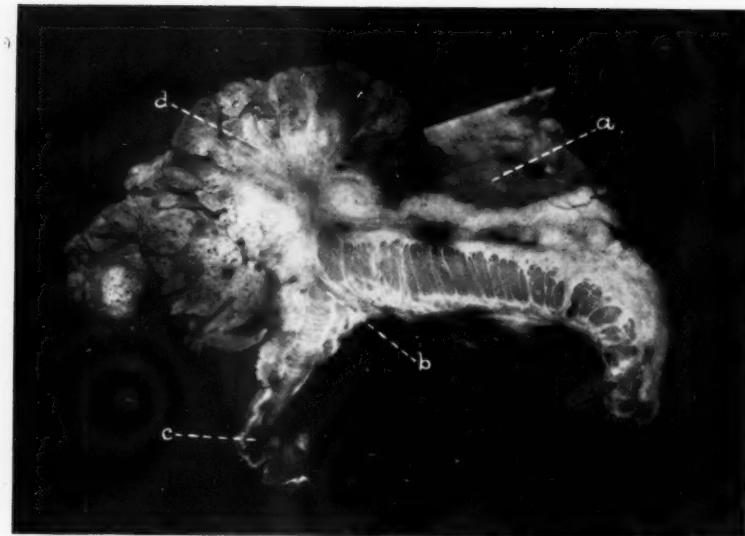
Case 77369. Microscopic section of margin of base of gastric ulcer showing cancer developing therein. *a*, granulation tissue in border of ulcer; *b*, cancer cells; *c*, scar tissue in base of ulcer. Compare with Fig. 2.

FIG. 6.



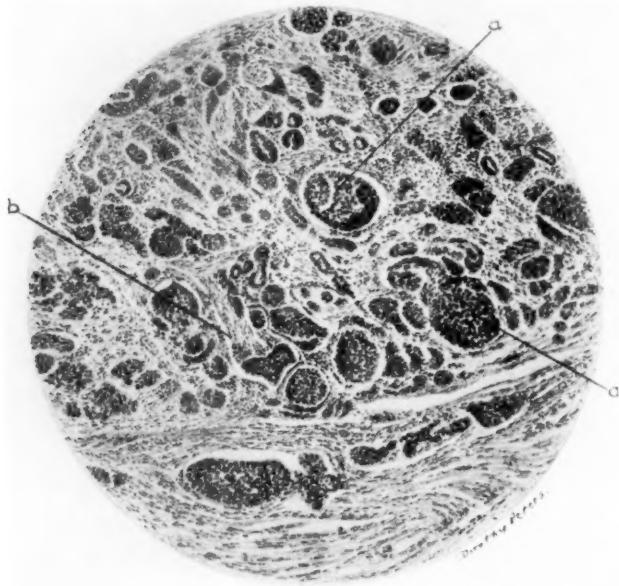
Case 1375GH. Microscopic section of margin of base of gastric ulcer showing cancer developing therein. *a*, granulation tissue in base of ulcer; *b*, scar tissue in border of ulcer; *c*, scar tissue in base of ulcer; *d*, cancer cells.

FIG. 7.



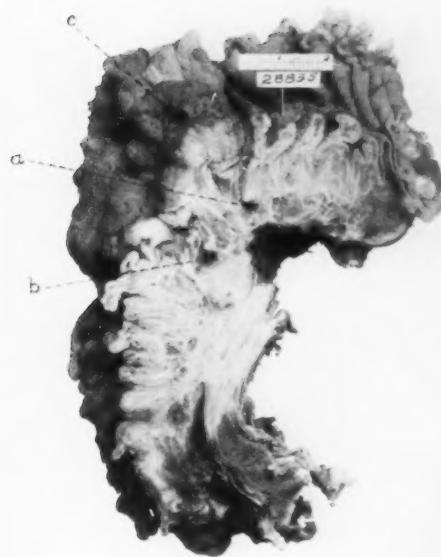
Case 61007. Gross section through pylorus showing cancer developing on a papilloma which springs from the duodenal side of the pylorus. *a*, gastric mucosa; *b*, pylorus; *c*, duodenum; *d*, cancer.

FIG. 8.



Case 25398 (H₃1025). Microscopic section through cancer in the tip of an appendix, the mucosa of which apparently had been obliterated by chronic inflammation. *a*, cancer cells; *b*, connective tissue.

FIG. 9.



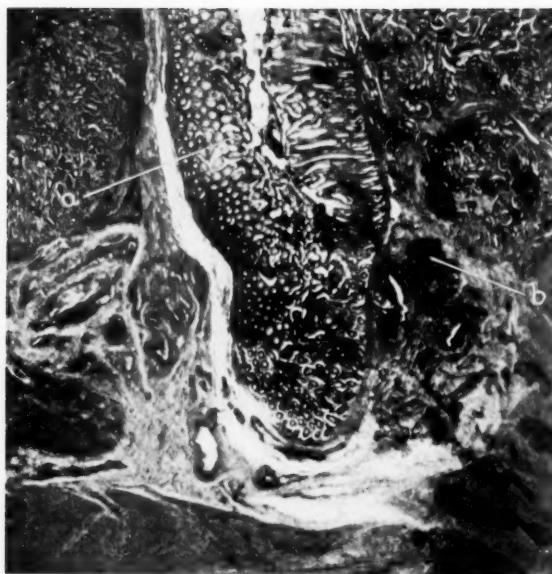
Case 18633G (H28835). Gross longitudinal section through specimen removed from sigmoid showing chronic diverticulitis with cancer developing thereon. *a* and *b*, diverticula; *c*, surface of cancer.

FIG. 10.



Case 18633G (H28835). Gross longitudinal section through same specimen as shown in Fig. 9 at level marked *c*, showing cancerous areas. *a*, cancerous mass surrounding almost completely obliterated diverticulum; *b.b*, metastatic cancer of lymph-glands; *c*, normal mucosa.

FIG. 11.



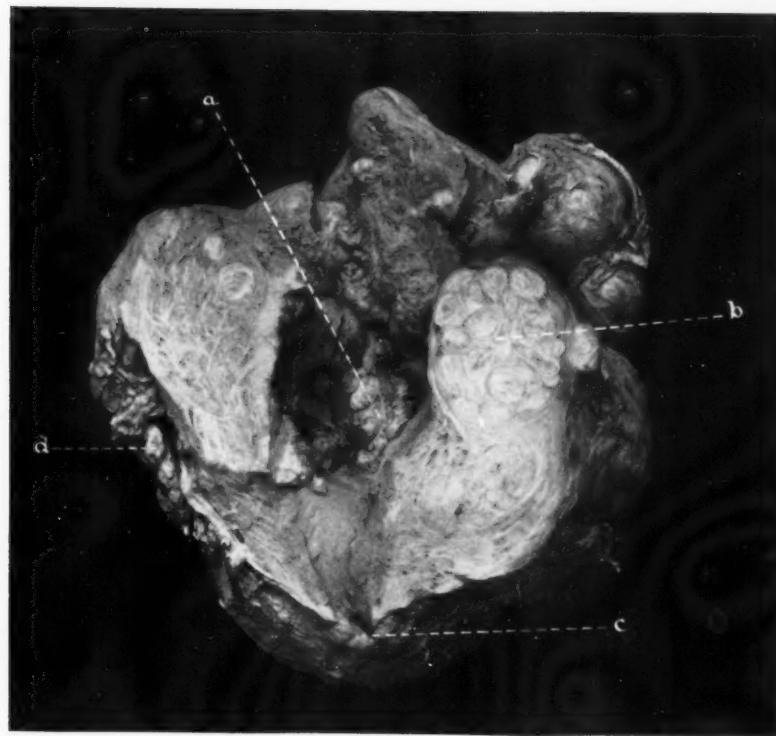
Case 9496G. Microscopic section longitudinally through a diverticulum of the sigmoid in the wall of which cancer has developed. *a*, hyperplastic mucosa; *b*, cancer.

FIG. 12.



Case 37405. Gross longitudinal section through the wall of rectum showing diverticula around which cancer has developed. *a,a*, diverticula; *b*, surface of cancer which, starting around the diverticula, has extended to the mucosa.

FIG. 13.



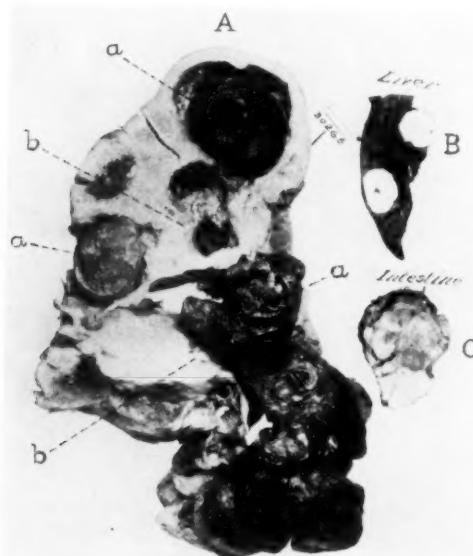
Case 46337. Uterus opened to show cancer beginning at point where endometrium has been chronically irritated by a fibroid in opposite wall of uterus. *a*, cancer; *b*, fibroid; *c*, cervix; *d*, right tube.

FIG. 14.



Case 83255. Gross section through kidney showing cancer developing in tissue chronically irritated by stones. *a,a*, stones; *b,b*, cancerous areas.

FIG. 15.



Case 30265. *A*, gross section through kidney removed at operation, showing cancer developing in tissue chronically irritated by large stones; *a,a*, stones; *b,b*, cancerous tissue; *B*, metastatic cancer in liver of same case (autopsy); *C*, metastatic cancer in wall of intestines from the same case (autopsy).

but in all our early operations lesions of a precancerous nature were found. Especially is this true of the sigmoid and rectum, where, in 37 cases of diverticulitis, the irritation of the little hard balls of fecal material in the ends of these pouches has given rise to malignant disease in twenty per cent. of the total^{29,30,31,32} (Figs. 9, 10, 11 and 12). It is probable that the supposed long duration of cancer of the large intestine, cases of which have been reported, were in reality tumefactions from chronic diverticulitis followed later by malignant change.

We must not lose sight of the fact that a changing physiology of an organ may be of itself a source of weakness and possibly act as a cause of local irritation. Such a change is undoubtedly going on in the proximal half of the large intestine. Plant life is parasitic on the inorganic world and depends on chlorophyl for its potency. We should know more about chlorophyl upon which in the last analysis life depends. Animal life is parasitic upon plant life, man on both plant and animal and increasing rapidly the flesh intake. Within the last 100 years, four times as much meat is taken as before that time.³³ If flesh foods are not fully broken up, decomposition results and active poisons are thrown into an organ not intended for their reception and which has not had time to adapt itself to the new function.

The development of malignant disease in the uterus and kidney shows the same relation to chronic irritation. Cancer of the cervix occurs fifteen times as frequently as cancer of the body of the uterus, but in myomatous disease cancer of the body of the uterus is found five times as frequently as cancer of the cervix, the chronic irritation of the uterine tumors increasing the incidence 75 times (Fig. 13).

Of all the cases of epithelial cancer of the kidney which came to operation in our clinic not less than 50 per cent. were demonstrably superimposed on extensive renal calculus formation (Figs. 14 and 15).

In conclusion, I would again call attention to the fact that pre-existing lesions play the most important part of the known factors which surround the development of cancer, that such precancerous lesions are produced by some habit

or life condition which causes chronic irritation, that where cancer in the human is frequent a close study of the habits of civilized man as contrasted with primitive races and lower animals, where similar lesions are conspicuously rare, may be of value, and finally, that the prophylaxis of cancer depends, first, on a change in those cancer-producing habits and, second, on the early removal of all precancerous lesions and sources of chronic irritation.

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SYSTEMIC BLASTOMYCOSIS.*

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THE knowledge of the fact that yeasts may act as pathogenic agents dates from the year 1890 when Grohe³ reported to the Greifswald Medical Society the result of experiments made by him with mould and yeast fungi injected into the blood or peritoneum of animals. These animals usually died shortly after injection. In 1892 Popoff⁴ employed ordinary commercial compressed yeast which was cut into small pieces, dried, ground to a powder, strained through a towel and injected into the blood-vessels, beneath the skin, and into the thoracic cavity of dogs. The animals usually died within a few hours or days, with septic phenomena. Popoff often noted the appearance of nodules, resembling tubercles, in the kidneys, spleen and lungs. Microscopically these nodules were found to contain yeast cells and starch granules. The above named experiments were made with impure material and were therefore hardly considered convincing.

The first article carrying fair conviction regarding the problem of pathogenic yeast was published by Raum⁵ who injected several kinds of yeasts into rabbits, apparently observing localization and growth of these microorganisms in the animal body.

In 1893 Tokishige,⁶ Professor at the Tokio Veterinary Academy, described an endemic disease of horses in Japan in which a fission fungus was found to be so abundant that, after prolonged microscopic examination, he believed himself justified in regarding it as the cause of the disease. This report attracted but little attention even from the veterinarians.

Busse⁷ and Buschke⁸ in 1894, reported in detail a case

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which came under their observation in the surgical clinic at Greifswald. Shortly thereafter, and independently, Gilchrist⁹ reported a case of skin disease, supposed to be due to yeasts, in man. However, in view of the fact that he made no cultures, his observation is hardly to be regarded as convincing. Busse would accordingly seem to be entitled to the credit of having been the first to make clear observations.

In a general way it may be said that the disease in animals, appearing in epidemics, is relatively benign in character. Many animals get well, while the majority of the fatal cases seem to succumb to exhaustion through the superficial distribution of the process rather than through its penetrating to the viscera. Buschke considers the avenue of entrance as ordinarily occurring through the skin, whence, in man, it is carried into the interior of the body. As far as he is able to ascertain, the distribution takes place by way of the lymph-channels through which the fungi reach the lymph-glands. In the rarer cases of retrogression of the local disease a subsidence of the pathological process can also be noted in the lymph-glands. For further and extensive account of the pathological process the reader is referred to this valuable and instructive article by Buschke.

In systemic blastomycosis, as well as in the cutaneous form, the most common change is represented by a simple mycosis. Proliferation processes may develop in the affected tissue much as they do in the so-called infectious granulomata.

An instructive communication was made in 1910 by Franchetti and Cazzaniga,¹⁸ who believed themselves justified, on the basis of cases described in literature, of personal experimentation and the experiments of others, in coming to the conclusion that yeast microorganisms undoubtedly possess pathogenic properties, although this particular family of fungi is very large and the group is still obscure.

As regards the clinical course of infectious blastomycosis, experimental findings serve to confirm the results of clinical observations. The course is usually slow, anaemia is present, there is generally progressive emaciation. Albuminuria is

frequent and the end is almost always fatal in the severe general infections and in the forms with localization in the nervous system. Any or practically all of the tissues of the body may be affected.

Two cases of systemic blastomycosis, both fatal, have come under my observation. The first was a man of forty-four years who gave the following history: He suffered from pneumonia at 19 years of age, while at the age of 23 years he had a bronchial cough which lasted for one year. Two years later this cough returned and continued for one year when he went to the Adirondacks, living there for about six months. He had had no subsequent chest trouble. At 32 years of age he noticed two small, soft lumps in the lower part of the neck, one above each collar-bone. These gradually enlarged and were removed 15 months later. No microscopical examination seems to have been made, the sinuses healed slowly.

In 1902 two small, hard nodules, each about the size of a pea, appeared in the lower part of the neck in the median line and were removed. One year later another nodule was removed. At this time the general health was considerably below par.

In the latter part of 1903 he went to South Carolina where the general condition tended to improve. At about this time another lump appeared but it gradually subsided. This lump re-appeared six months later and was taken out. In 1906, while in Europe, he suffered attacks of indigestion and jaundice, these attacks lasting two or three months. From this time, 1906, until the autumn of 1910, his general condition remained fairly good. He spent the winter of 1910-11 in California and during these winter months many lumps appeared below the lower jaw on each side. He passed the spring of 1911 in Arizona, coming to Denver in June, at which time I found the entire neck below the lower jaw, on each side, filled with hardish lumps and presenting multiple sinuses. The general condition was much impaired. I cleared the neck thoroughly on each side, but through some unfortunate error, possibly owing to the fact that I was leaving town, the tissues were not histologically examined. My own clinical diagnosis was tuberculosis. Two or three weeks after this operation upon the neck small, soft lumps appeared on the

abdomen and thighs beneath the skin. These were opened, discharging pus and healing rather slowly.

In August, 1911, evidence of disease of the two last dorsal vertebræ was found, both on examination and by the X-ray.

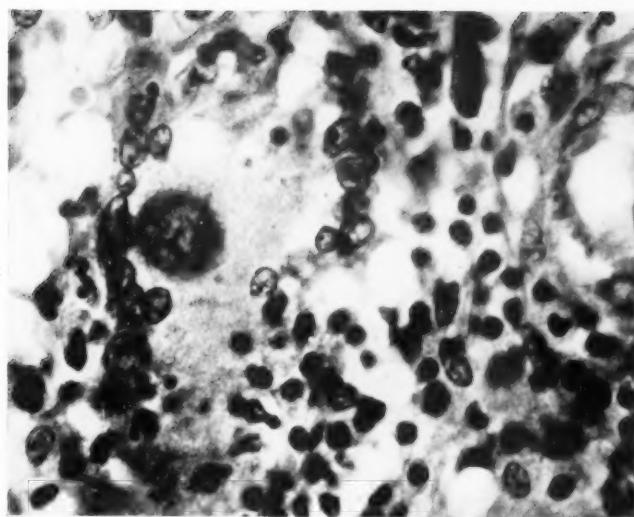
In October, 1911, on my return from Europe, I opened a number of moderate sized abscesses on the back, thighs, and right hand. Cultures from these abscesses gave pure blastomycosis. From time to time other abscesses appeared in different parts of the body and on being opened showed, on culture, the same micro-organism. Thoracic and abdominal symptoms came on and from August, 1911, the patient's health gradually failed. Management rested on general tonics, the best possible attention to the general health, and on the occasional employment of potassium iodide and cupric sulphate. These latter drugs were not well borne and he died from exhaustion April 20, 1912. Autopsy was made by Dr. Ross C. Whitman, Professor of Pathology in the University of Colorado. Dr. Whitman's report is as follows:

Pathological Diagnosis.—Sinuses angle of left jaw, right side of neck above clavicle, extensor surface right thumb and on back. Six openings at various levels either side of spinal column, and one on inner aspect left thigh. Emaciation. Multiple miliary abscesses of liver; 2 miliary abscesses spleen; caries thoracic spine; iliopsoas abscess (moderate size, not prominent); miliary abscess pelvis left kidney; nephritis(?) acute, fibrinous, left-sided pleurisy with exudate. Destruction lower lobe left lung.

Dr. Whitman further reports: "The lesions found macroscopically in bone, liver, pleura and submaxillary lymph-nodes, as well as the microscopic lesions found in the spleen, are everywhere essentially alike, the differences being apparently due in part to the stage of development of the individual lesion, and in part to the physical conditions, as in the pleura, where the character of the serous membrane and friction have somewhat modified the picture. The main features of the disease process can be reconstructed in considerable detail.

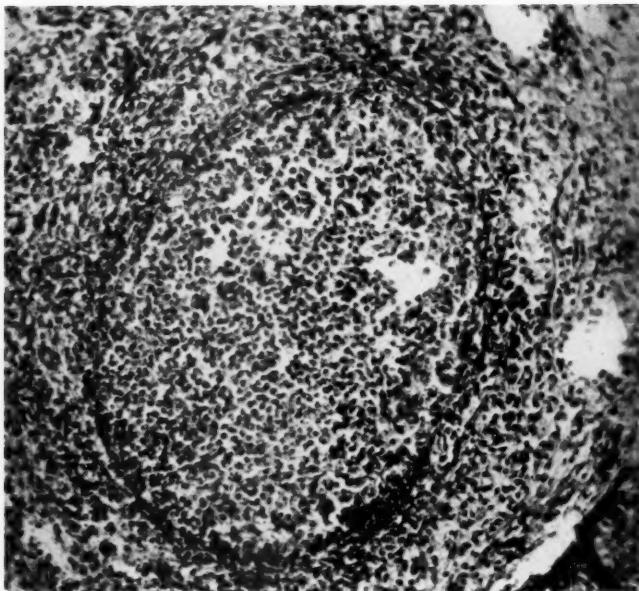
"The organism lodges first in a small vessel or capillary. The endothelial cells proliferate, becoming larger and plumper, and separate from the wall. Later they may fuse about the organism to form a typical giant-cell of the Langhans type. The vessel is occluded, and the vessel wall disappears, leaving a collection of endothelial cells. This enlarges, encroaching on the surrounding parenchyma, which disappears, leaving a supporting connective tissue stroma and capsule. The connective tissue also increases to some extent, and may organize the lesion, replacing it by scar tissue. In the earlier stages of the lesion there is more or less

FIG. 1.



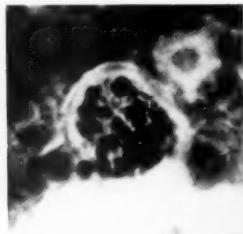
Intravascular formation of giant-cell about a blastomycete. Zeiss apo. obj. 2 mm. oil immersion, comp. oc. No. 8.

FIG. 2.



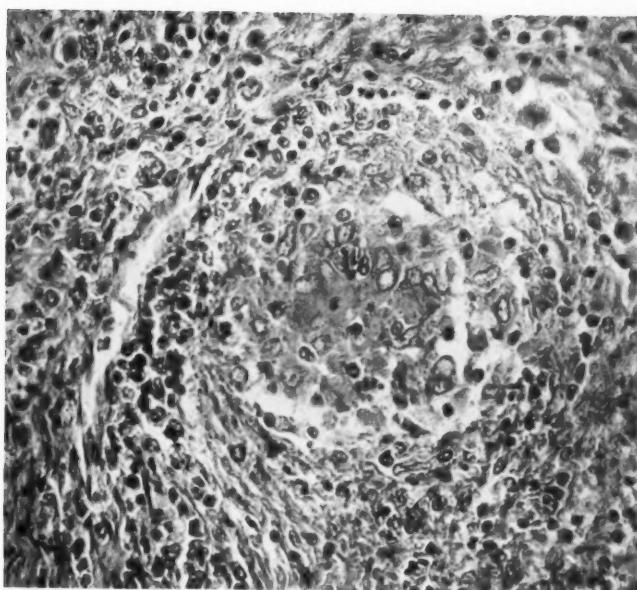
Small granuloma from pleura, consisting of a collection of endothelial leucocytes (endothelial cells). The wall in this case consists of fibrin. Zeiss apo. obj. 16 mm. without ocular.

FIG. 3.



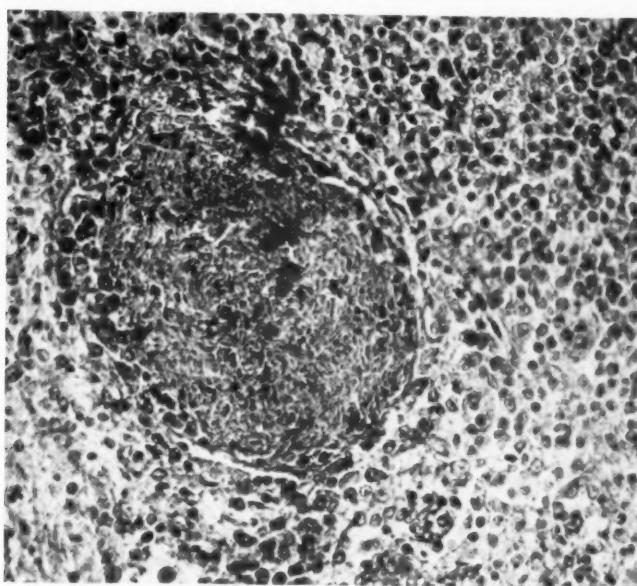
Blastomyces showing endosporulation (ascus formation). Zeiss apo. obj. 2 mm., comp. oc. No. 4.

FIG. 4.



Small lesion from spleen. Group of endothelial cells, with beginning necrobiosis and infiltration of polymorphonuclear leucocytes. Magnification as in Fig. 3.

FIG. 5.



Lesion from spleen showing early fibrosis. Magnification as above.

infiltration by leucocytes among which plasma cells and eosinophilic myelocytes are a striking feature, which serves at once to distinguish the process from tuberculosis. Somewhat later the cells of the lesion undergo a wide-spread and uniform coagulation necrosis, similar to the type commonly met with in rapidly growing malignant tumors, and differing from caseation in the fact that the structure of the cells can be recognized for some time after necrosis has taken place. Lesions as large as 1-2 cm. in diameter may consist of a capsule surrounded by a narrow zone of leucocytes and small daughter lesions, and containing a pasty mass of necrotic cells with little or no living tissue. Ultimately, the dead tissue is extensively infiltrated by polymorphonuclear neutrophiles, the disintegration of which, with the resulting liberation of proteolytic ferment, is doubtless responsible for the liquefaction which occurs.

"The process in the pleura is modified by the pouring out of a profuse fibrinous exudate in which abundant pus cells are found. Apparently there has been no tendency to walling off, the exudate having spread uniformly over the entire serous membrane.

"The organism is found fairly abundantly in all the lesions. It was described in some detail by myself in a paper published last summer (*Journal Infectious Diseases*, vol. xiii, p. 85, 1914). It will suffice here to call attention to the fact that unquestionable budding forms are not found. Multiplication seems to take place only by 'endosporulation,' which in the paper above mentioned is interpreted as ascus formation. I can but think that the original condition in this case was blastomycosis."

My second case was observed some years ago and in its main features followed the course of the one just narrated, excepting that the original focus was a nodule at the back of the left hand, which nodule had undergone suppuration and curetting some three years before the patient came under my observation. The case terminated fatally with thoracic, abdominal and joint lesions. The histology and bacteriology were carefully studied and reported upon by Dr. J. A. Wilder, at that time Professor of Pathology in the University of Denver.

The literature upon this subject is abundant and need not be reproduced here. The central thought in my mind is that the systemic form of blastomycosis is almost invariably fatal and that this grave condition generally begins in a small local focus. I believe that such local focus or foci should be very widely excised as early as possible, in order to attempt to fore-stall dissemination.

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THE VALUE OF GLUZINSKI'S TEST IN THE DIAGNOSIS OF GASTRIC ULCER.*

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THE chemical analysis of the stomach contents after test-meals is of relative value but not pathognomonic.¹ Many surgeons of large experience are even of the opinion that the chemical analysis takes only a very subsidiary place in the diagnosis of diseases of the stomach.

It therefore created considerable attention, when Kocher at the German surgical congress, 1912, recommended Gluzinski's reaction as a means of making the differential diagnosis between ulcer and cancer, thus bringing to the fore a half-forgotten method described for the first time some ten years ago.

Gluzinski² proceeds from the supposition, which is now going to be accepted as a fact, that a great number of cases of cancer of the stomach develop upon the basis of an ulcer.

His working hypothesis is as follows:

An *ulcer* situated in the pyloric portion being the cause of retention is, as a rule, accompanied by *hyperacidity* of the contents, while a *cancer* is attended by a mucous (or atrophic) catarrh which causes a *disappearance of the free hydrochloric acid*.

During the transformation of an ulcer into a cancer there will yet be found free hydrochloric acid up to a certain stage of the disease. But during the progress of the mucous catarrh there will occur a *secretory insufficiency* which may be

* Read before the American Surgical Association, April, 1914.

¹ W. J. Mayo: Operative Treatment of Cancer of the Stomach. Journal of the Amer. Med. Assoc., Bd. 61, No. 8.

² Gluzinski: Ein Beitrag zur Frühdiagnose des Magenkrebse. Mitt. aus d. Grenzgeb. d. Med. u. Chir., Bd. x, 1902, p. 1.

demonstrated by giving two test-meals, one meal following immediately upon the other.

Gluzinski examines the gastric contents (1) recovered from the fasting patient; (2) after administering a test breakfast consisting of the white of a boiled egg and 200 c.c. of water which is recovered after three-quarters of an hour; (3) after a test dinner consisting of a beefsteak and 250 c.c. of water which is recovered after three and three-quarters hours.

The stomach is washed out before and after the first meal and the second meal is given immediately after the second washing.

In *ulcer* both the breakfast as well as the dinner give distinct reaction of free HCl.

In beginning cancer the *first meal* also will give distinct reaction of free HCl, while the *second one* will show only a slight trace, or free HCl will be altogether absent.

He diagnosed a beginning cancer in 3 cases, the diagnosis being verified at subsequent operation.

This method is being utilized by Kocher who has somewhat modified it and enlarged upon its applicability.

By determining the percentage of free HCl in the two meals he has found that the free acid is present in larger quantities after the second meal in *ulcer*, while in *cancer* this meal (the test dinner) shows the lowest percentage of hydrochloric acid.³

The preëminence of this method is that the diagnosis of *ulcer* or *cancer* is *not* based on the *absolute* value of free HCl in the gastric contents, but on the *increase* or *decrease* in the amount of free acid in the recovered meals.

But, moreover, he believes that the method may be used also in the *absence* of free hydrochloric acid in which case the *total acidity* shows the same proportions, always supposing that there is no lactic acid present.

In 30 cases of *ulcer* tested according to this modified

³ The cases tested in this way at the Clinic Berne are described by Fonio: Ueber die Resultate der Untersuchungs methode nach Gluzinski u. s. w. Deutsche Zeitschr. f. Chir., Bd. 116.

Gluzinski method, the diagnosis was verified at operation in 27 cases, in 2 cases the result was uncertain and in 1 case there was found carcinomatous degeneration of an ulcer, although the test indicated the presence of a simple ulcer. (Borghis or Petit.)

The results obtained by Kocher are to some extent being contested by Dr. Rusca,⁴ Berne, while Kleinschmidt⁵ and Hohlbaum,⁶ both of Leipzig, speak very approvingly of the value of the test.

Before describing our own experiences I must state that both Gluzinski himself as well as Kocher and those who later have adopted the method most emphatically take reservations against the belief that they are accepting the results of this chemical reaction as decisive for the diagnosis. It is nothing but a symptom which is to be judged in conjunction with the other symptoms and with the history of the case.

As to the *theoretic foundation* for the method this seems to be pretty well laid.

My first assistant, Dr. Backer-Grondahl,⁷ has made some examinations upon an otherwise healthy person with a gastric fistula established because of a cicatricial stricture of the cesophagus.

Grondahl administered Gluzinski's test-meals through the fistula and the results of his examinations are in accordance with those already known from the experiments of Pavlow upon animals and from the experiments by Hornberg upon the case of a patient with gastric fistula.

There occurs reflexly an increased production of gastric juice when the gastric mucous membrane receives an increased food irritation.

⁴ F. Rusca: Beitrag zur Magendiagnostic, etc. Correspondenz-Blatt f. Schweizer Aerzte, 1913, No. 46, p. 1498.

⁵ Kleinschmidt: Uberblick über das Magenmaterial der Leipziger chir. Universitat klinik.

⁶ Hohlbaum: Ergebnisse der Salomonschen und der Gluzinskischen Probe, etc. Centralblatt f. chir., 1913, No. 35.

⁷ N. Backer-Grondahl: Forelobige resultater med. Gluzinski's undersøkelsesmethode, etc. Nordisk Tidsskr. f. Terapi, xi, Aarg 11 H, 1913.

It has been shown that not only is the amount of gastric juice increased but also is the concentration of the hydrochloric acid greater as the irritation increases.

At the surgical clinic of Christiania University we have employed the Gluzinski method since October, 1912, in the examination of 86 cases, to wit: 25 cases of gastric ulcer, 9 cases of duodenal ulcer, 21 cases of cancer of the stomach, 15 cases of gastro-enteroptosis, 11 cases of chronic appendicitis and 5 cases of gall-stones.

The diagnosis is in all of the cases controlled by operation, some of the ptosis cases only by röntgenogram.

Of our *cancer* cases two only had free hydrochloric acid and in both the test agreed with the results as obtained by Gluzinski, to wit: a *decreasing* amount of free hydrochloric acid in the test dinner (Fig. 1).

In those cases of cancer of the stomach where free hydrochloric acid was absent we have found *no regular decrease of the total acidity*; we are so far unable to support the statement made by Fonio, that the method may be used in such cases.

In fact, the total acidity was *increasing* in the second test-meal in about 50 per cent. of the cases.

During our further examinations we soon arrived at the conclusion, however, that the percentage of free HCl may *decrease* in the second meal *also in diseased conditions of the gastro-intestinal canal other than cancer of the stomach*.

We found the free hydrochloric acid values to be diminishing in the test dinner in cases of *gastro-enteroptosis*.

But not in all of them—the phenomenon was not dependent upon the anatomical position of the gastro-intestinal canal in itself—we found it in cases where chronic obstruction appeared simultaneously with gastro-enteroptosis (Fig. 2). Cases of gastro-enteroptosis without obstruction are shown on Fig. 3.

In the first of those cases we made resection of the pylorus because we imagined that we felt a hard little knot in the wall of the stomach. But microscopical examination of the

FIG. 1.

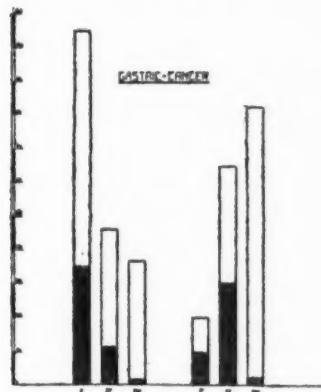


FIG. 2.

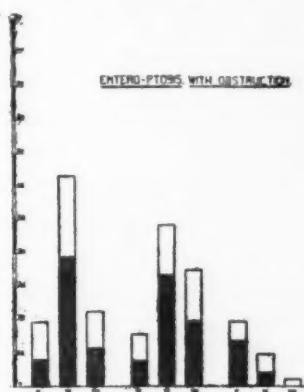


FIG. 3.

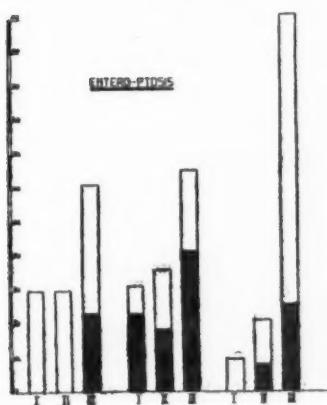


FIG. 4.

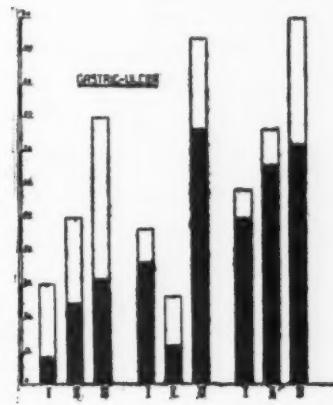
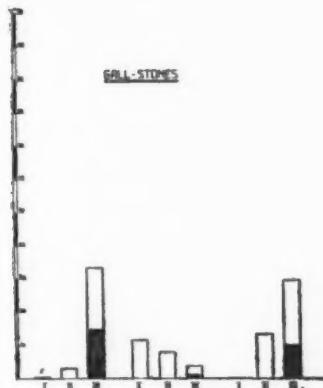


FIG. 5.



Diagrams of acid-values in the gastric contents. I, recovered from the fasting patient; II, recovered after the test breakfast; III, recovered after the test dinner. Black: free hydrochloric acid; white: total acidity.

resected piece did not show any traces of cancerous degeneration.

Gluzinski's test is a test of function, which demonstrates the failing ability of the mucous membrane to secrete hydrochloric acid.

But this failing ability may be found also in other conditions than those prevailing during the development of a cancer. Further experience will show which are those conditions.

It only confirms the statement made by Dr. W. Mayo that the "early diagnosis of cancer does not depend on any sign or symptom due to the cancer itself."

By examining 25 cases of *gastric ulcer* we found that all of them but one⁸ reacted in the manner described by Gluzinski and Kocher as being characteristic of ulcers of the stomach, to wit: with a decided increase in the percentage of the hydrochloric acid and of the total acidity.

After ingestion of the beefsteak rather high values of hydrochloric acid are obtained, and this is possibly most pronounced in those cases in which the dyspeptic symptoms are most severe (see Fig. 4).

So strongly pronounced and so apparent has this phenomenon been in our cases that it possibly may be used as a differential symptom in the diagnosis between ulcer and other diseased conditions of the gastro-intestinal tract attended by dyspepsia.

Thus in two cases referred to us from the medical ward with the diagnosis of callous ulcer—in one of them this was even the Röntgen diagnosis—we found hypo-acidity with very little increase after the test dinner.

In none of them was ulcer found at the operation. A few adhesions between the duodenum and the gall-bladder were separated and both patients have later informed us that they

⁸ Male aged forty-four years. The hydrochloric acid percentage after the beef-meal decreased a little, while the total acidity increased. The difference was, however, slight and at the operation it could not be decided whether a cancer positively was developing or not, as the stomach was imbedded in a mass of firm perigastric adhesions.

have got rid of their previous very severe symptoms after the operation.

On Fig. 5, I have given a graphic diagram of the acid values found in some cases of gall-stones examined according to Gluzinski's test.

By comparing the columns with those belonging to ulcer cases (Fig. 4) the difference will seem striking.

In our 9 examined cases of duodenal ulcer the hydrochloric acid values were not as high as in gastric ulcer and the increase in the percentage of free acid in the second meal was moderate in 7 cases, while it was relatively great in two cases.

But the difference in this respect between gastric and duodenal ulcer is not great enough to be made use of as a means of differential diagnosis.

We have tried to differentiate between various forms of appendicular dyspepsia, but have as yet obtained no definite results.

In our opinion Gluzinski's method is better than any other for testing the secretorial function of the stomach.

Thus, in cases where free hydrochloric acid apparently is absent and not to be found after an Ewald's test breakfast, the second meal in some cases will produce a gastric juice containing hydrochloric acid.

As a whole, we have found Gluzinski's test reliable. It ought to be used as a help to make the differential diagnosis in doubtful cases of gastric ulcer.

A METHOD OF SUBTOTAL GASTRECTOMY.*

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I AM emboldened to bring the operation described in this paper to the attention of the Association because of the difficulties that are sometimes experienced, after partial removal of the stomach, in joining the first segment of the jejunum with the posterior wall of the gastric stump, and because of the obvious disadvantages of the simpler but more dangerous anterior, antecolic, long-loop gastro-enterostomy. Billroth's first method (end-to-end anastomosis between the stomach and the duodenum) and Kocher's implantation of the open end of the duodenum into the posterior wall of the stomach are, I imagine, rarely considered at the present time, owing to the great tension exerted on the anastomotic sutures, especially if one removes as much stomach as is demanded in the modern operation for carcinoma of the pylorus.

The method of subtotal gastrectomy that I desire to submit for criticism consists in removing the diseased segment of stomach from left to right, after performing an end-to-side anastomosis between the lower portion of the incision, which amputates the stomach and the upper part of the jejunum, the operation being so conducted that the suturing necessary to unite the stomach to the intestine is completed before either viscus is opened.

The gastric artery is doubly ligated at the upper end of the proposed line of section of the stomach, and divided between the ligatures. The gastrohepatic omentum is tied in sections and severed. The left gastro-epiploic artery is ligated about one-half inch on each side of the lower end of the proposed line of section of the stomach, and the segment of artery between the ligatures excised. The gastrocolic omentum is tied

* Read before the American Surgical Association, April 9, 1914.

and cut, from a point about two inches to the cardiac side of the selected line of gastric amputation to the duodenum. The transverse mesocolon is drawn taut, without pulling the colon from the abdominal cavity, and a hole torn in this membrane, from the upper side, within the arc of the midcolic artery. The upper end of the jejunum immediately bulges into this opening and is drawn into the lesser peritoneal cavity. A suture is passed through the greater curvature of the stomach, midway between the ligatures on the left gastro-epiploic artery, and through the antimesenteric border of the jejunum, at a point about five or six inches below the origin of the jejunum, the distance varying according to the degree of dilatation of the stomach. By pulling upward on this suture the posterior wall of the stomach and the upper segment of the jejunum are brought in contact. A suture uniting the posterior wall of the stomach to the intestine is inserted about three inches above the original suture, and a third suture is passed through the posterior wall of the stomach alone, an inch or more above the second suture (Fig. 1), both of these sutures being on the line through which the stomach is to be amputated. Two sutures are now placed in the anterior wall of the stomach, at points corresponding to the upper sutures in the posterior wall (Fig. 2). The point at which each anterior suture is to be inserted may be determined easily by grasping the stomach with the left hand in such a way that the index finger presses the point of insertion on the posterior wall up against the corresponding point on the anterior wall, which point is marked by the thumb. Suture *A* is now drawn upward and to the right (*i.e.*, toward the patient's right shoulder), sutures *B* and *D* downward and to the left (*i.e.*, toward the patient's left hip) and tied together, sutures *C* and *E* likewise downward and to the left and tied together (Figs. 3 and 4). The upper segment of the jejunum is thus surrounded by the stomach, the anterior wall of which lies against the right side of the bowel, the posterior wall against the left side of the bowel. Between sutures *B*, *D* and sutures *C*, *E* the anterior and the posterior walls of the stomach are in contact, which contact is made

permanent by the introduction of a seroserous suture of celluloid thread, which suture is continued from *B*, *D* to *A*, uniting the anterior wall of the stomach to the bowel, and from *A* back to *B*, *D*, uniting the posterior wall of the stomach to the bowel (Fig. 4). This seroserous suture is overlaid by a through-and-through catgut suture, and sutures *B* and *D* cut off short. The greater curvature of the stomach is grasped with forceps about one-half inch from *A* (Fig. 5), and the lesser peritoneal cavity filled with gauze. The portion of the anti-mesenteric border of the intestine exposed between the rows of sutures is excised, and an incision made in the stomach close to the suture line, beginning at *G*, passing between *A* and *F*, and ending at *H* (Fig. 5). After ligating any vessels which have not been caught by the sutures, thread *A* is cut and the stomach allowed to straighten itself (Fig. 6). A clamp is placed across the stomach to the pyloric side of the line of section, and the amputation completed after approximating the anterior and the posterior walls of the stomach, between *J* and *K* (Fig. 6), by several through-and-through sutures of catgut, which sutures are buried by an inversion seroserous suture of celluloid thread. It is well, but not essential, to insert the uppermost inversion suture before completing the amputation of the stomach, since by pulling on this suture the raw edges, which are already inverted at the lower end (*J*, Fig. 6), recede between the serous coats, which can then be rapidly sutured (Fig. 7). The pyloric segment of the stomach is drawn from the abdominal cavity and turned over on the patient's right hypochondrium, the superior pyloric and the gastroduodenal arteries secured above and behind the pylorus, the duodenum severed between ligatures, and the duodenal stump inverted. The edges of the rent in the transverse mesocolon may be attached to the jejunum or, if there is much gastrectasia, to the stomach.

The operation just described may be performed in any case of gastrectomy in which posterior gastro-enterostomy is applicable, and perhaps in some in which, owing to the small size of the gastric stump, posterior gastro-enterostomy would

FIG. 1.

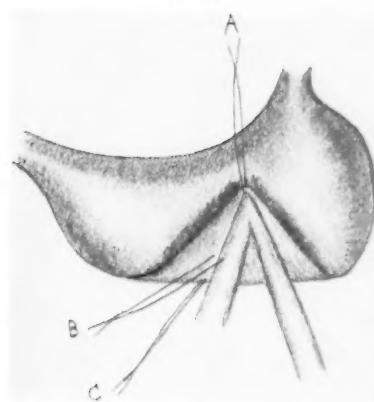


FIG. 2.

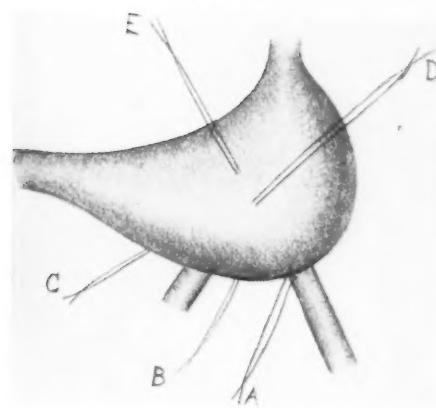


FIG. 3.

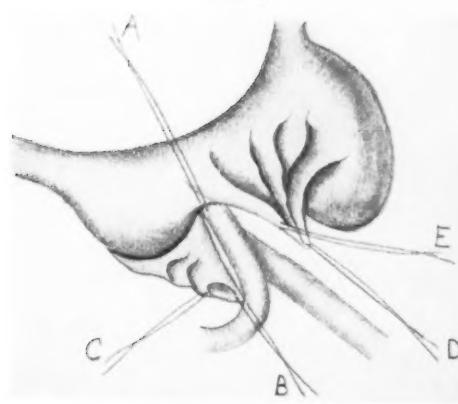


FIG. 4.

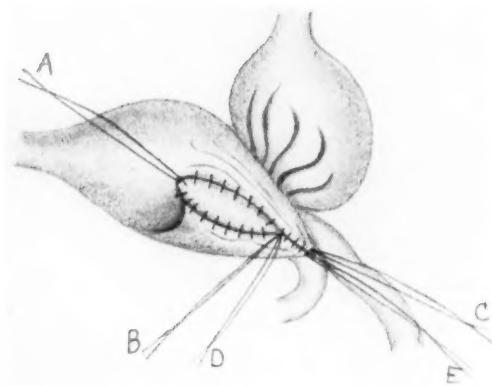


FIG. 5.

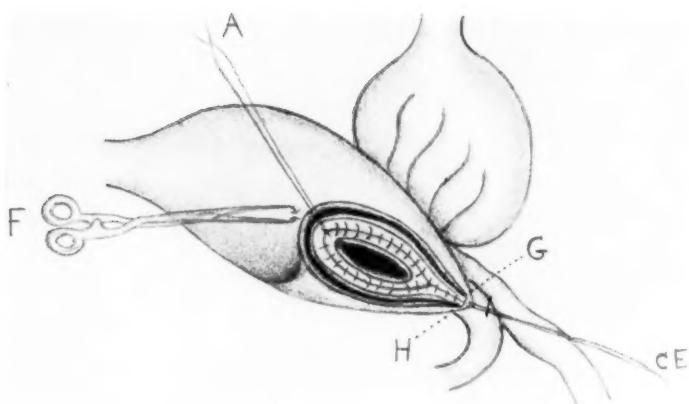


FIG. 6.

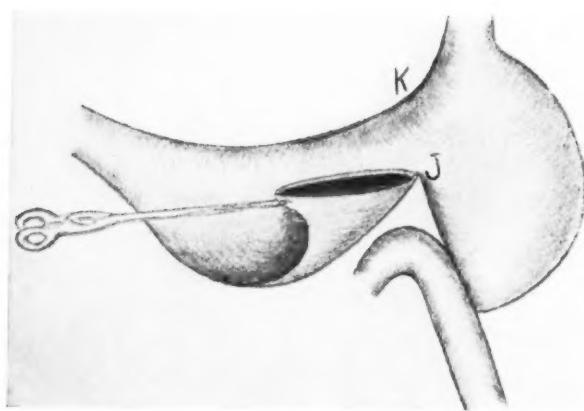
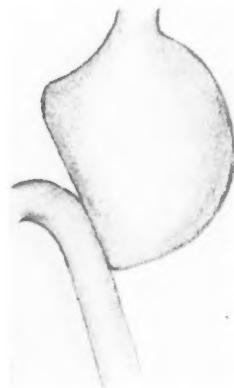


FIG. 7.



be injudicious. With equal practice in the two operations the newer one should be less difficult and more rapid; there is less cutting to be done, consequently less suturing; the lower part of the incision for amputating the stomach serves at the same time for the anastomotic opening. In the newer method the anastomotic opening is at the lowest part of the stomach, and all of the anastomotic sutures and a portion of the sutures which close the stomach above the anastomosis, are in place before either the stomach or the intestine is opened. When the incisions are made the cut edges are in view, unrestrained by clamps, so that haemostasis may be made absolute. Gastro-enterostomy with clamps is often followed by bleeding, and sometimes by a hemorrhage which necessitates reopening of the abdomen. I suspect also that the bruising exerted by clamps may be partly responsible for some of the cases of non-union of the sutured surfaces after gastrectomy for carcinoma, and perhaps also for some of the ulcers which occur at or near the line of anastomosis after gastro-enterostomy for peptic ulcer. Aside from these disadvantages which attend the use of clamps, they are always in the way, and occasionally, during gastrectomy, the one placed on the cardiac end of the stomach slips, especially when it is turned to facilitate suturing. If the stomach is well cleansed by gastric lavage previous to operation, if the patient is not allowed to retch during operation, and if the guide sutures are kept taut, and the site of anastomosis is well elevated above the incision in the abdominal wall, there is no danger of leakage from either the stomach or the intestine in the method I have just described. With this method there is less tension on the anastomotic sutures and less tendency to kinking than when the jejunum is anastomosed to the posterior wall of the stomach at a point which must, of necessity, be farther to the patient's left. In posterior gastro-enterostomy after partial gastrectomy there may be, from a theoretic stand-point, some danger that the gastric incision for anastomosis, which is usually parallel or nearly parallel with the sutured edges of the stomach at the line of amputation, may interfere with the blood supply to these sutured edges.

THE FUNCTION OF THE GASTRO-ENTEROSTOMY OPENING IN CASES OF PERMEABLE PYLORUS.*

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WHAT becomes of the gastrojejunal mouth and how does it work in case of a permeable pylorus? Such are the two points to which I wish to draw attention.

I. *Does the gastro-intestinal mouth obliterate anatomically in case of patulous pylorus?* Kelling,¹ in Germany, suggested that in cases where the pylorus is free, the gastro-intestinal opening might be subject to anatomical obliteration in consequence of the fact that the chyme passes through the pylorus and does not pass through the artificial opening. His opinion has been accepted in France by Tuffier,² Reynier,³ Jaboulay,⁴ Mathieu,⁵ Ricard,⁶ and is almost general.

Personally, I disagree with this opinion, being unwilling to admit that the anastomosis thoroughly lined by a mucous membrane and free from any scar tissue should become obliterated merely because of its non-use. This would be against all the rules of general pathology.

When we refer to the cases of anatomical obliteration of the gastro-intestinal anastomosis, we see that these obliterations are in no way connected with the permeability of the pylorus.

In 45 cases of anatomical obliteration of the gastro-intestinal mouth, which we gathered in literature, we only found 4 cases of permeable pylorus. In 7 cases the cause of obliteration has been undoubtedly the secondary development and the cicatrizing of a peptic ulcer of the gastrojejunal mouth (Kauffmann,⁷ Krönlein,⁸ Navarro,⁹ Gosset,⁹ Leriche,⁹ Oviatt¹⁰). In the 34 other cases the mechanism of the obliteration appears less distinctly. We observe, however, that in 23 cases buttons were used (Bérard¹¹ 1 case, Czerny¹² 4, Ettlinger¹³ 1, Feldmann¹⁴ 1, Ferrari¹⁵ 2, Jaboulay⁴ 1, Kehr¹⁶ 1, Leriche¹⁷ 1,

* Read before the American Surgical Association, April 10, 1914.

W. Mayo¹⁸ 4, Moynihan¹⁹ 2, Schloffer²⁰ 5), that in 4 cases sutures were used (Eiselsberg,²¹ Hartmann, Ricard, Tuffier), and that in 3 cases Y-shaped gastro-enterostomy was performed (Fedoroff,²² Monprofit, Roux). In the last 4 cases technical details are lacking.

Briefly then:

(1) The obliteration of the gastro-intestinal mouth is in no way connected with the more or less permeability of the pylorus.

(2) Undoubtedly the obliteration results sometimes from the cicatrization of a peptic ulcer having developed itself in the mouth.

(3) The technic used has a direct bearing on the result. Obliteration of the anastomosis is exceptional in cases not operated with button or by the Y-method. On the other hand, the integrity of the anastomosis has been anatomically ascertained in cases of pylorus functionless, by Henck,²³ after 3 months, by Scheuen²⁴ after 28 months, by Busch²⁵ after 6 years, by myself after 5 years.

II. *Are the gastro-intestinal anastomoses functionally useless in cases of permeable pylorus?* In 1908, after summarizing the experiments made by Blake and Cannon, Leggett and Maury, Kelling, Delbet, Tuffier, adding to these experiments some radioscopic examinations on men, two observations of duodenal fistula by Berg, in which all the gastric contents passed through the fistula notwithstanding a gastro-enterostomy, Guibe²⁶ concludes: "All the experiments on animals and observations on men seem to agree sufficiently to prove that as long as the pylorus remains permeable, the stomach has an almost invincible tendency to drive out its content through this orifice without being inclined to utilize the artificial mouth. Nothing whatever passes through the new opening; on the contrary, everything passes through the pylorus."

This opinion, clearly expressed, may be considered as generally accepted, even up to this day.

However, when we read the reports of the radiologists, we see that the facts do not agree absolutely with these con-

clusions. Legueu²⁷ observes that in a case of permeable pylorus all the gastric contents pass through the mouth. Bérard and Delbet²⁸ have shown us that the gastric contents pass as well through the mouth and through the pylorus. Pess,²⁹ after having studied 40 gastro-enterostomies by the X-rays, comes to the conclusion that the stomach (its pylorus being permeable or not before the operation) empties itself continually by the mouth and by the pylorus. Gray,³⁰ in a case of ulcer without stenosis, finds that the gastric contents pass specially through the mouth. Petrév³¹ examines 9 cases of gastro-enterostomy for gastric lesion with integrity of the pylorus; 4 times all the gastric contents passed through the mouth, twice through the pylorus, 3 times through the pylorus and through the anastomosis. In 4 cases of normal pylorus, Härtel³² finds that the evacuation takes place as well through the pylorus as through the mouth (1 case 2 years, and one 7 years after operation). Hesse³³ finds in 9 patients that the gastric contents pass through the mouth and through the pylorus.

These quotations prove sufficiently that the opinion of those who affirm the functional uselessness of the gastro-enterostomy in cases of permeable pylorus, is not as exact as they suppose, and that it is necessary to modify their too absolute affirmation.

To elucidate the question, I have made two kinds of researches:

1. Experiments on dogs.
2. Radiological examinations of patients.

EXPERIMENTS ON DOGS (IN COLLABORATION WITH MY PUPIL, M. MÉTIVET).

Dog 1.—Gastro-enterostomy joining the terminal portion of small intestine and pyloric antrum. Section of the intestine above the anastomosis suturing its proximal end to the skin, closing its distal end.

The dog lived 13 days without expelling any faeces through the rectum. We supposed that the anastomosis had not acted. At the post-mortem, we found a stomach containing intestinal fluid, the efferent portion of the intestine being empty, and numerous adhesions at the point of the anastomosis. The fluid introduced into the stomach passed with much difficulty through the mouth.

Dog 2.—Gastro-enterostomy between the initial portion of small

intestine and the fundus of the stomach. Thirty-seven days later, the dog is vomiting intestinal liquid and shows all the symptoms of intestinal obstruction. Next day we gave it 300 gr. of milk and half an hour later we killed it. At the post-mortem the stomach contained a yellowish fluid of fecal odor with clots of milk. This did not pass either into the duodenum, nor into the jejunum. The mouth was anatomically in good condition but obliterated by a bone which was impacted in its aperture and obstructed, on the other hand, the intestine. The intestine was distended by the liquid reaching the point of anastomosis and was contracted just behind the anastomosis.

Dog 3.—Gastro-enterostomy between the initial portion of the jejunum and pyloric antrum. Forty-four days after the operation the intestine is cut just above the anastomosis. The end in connection with the anastomosis is closed and the duodenal end is fixed to the skin.

The next day a meal composed of milk and hashed meat is given to the dog, which it eats with good appetite. After 7 or 8 minutes some bile is coming out of the duodenal opening and 15 minutes afterwards a few small curds of milk mixed with the bile. Half an hour after the meal the dog is killed. In the duodenum some bile and a few curds of milk are found representing what has passed through the pylorus. In the jejunum, at a distance of about 65 to 70 cm, one perceives a quantity of clots of milk and some particles of meat, showing what has passed through the gastro-intestinal mouth, which is normal, the pylorus likewise.

Dog 4.—Gastro-enterostomy between the initial portion of the jejunum and the pyloric antrum. Forty-six days after the operation, the intestine was cut above the anastomosis, exactly as in the former cases, the end attached to the stomach was closed, and the duodenum fixed to the skin.

After 3 days, 400 gr. of milk were given, 10 minutes later, a small quantity of milk was flowing through the duodenal fistula. The animal was killed 20 minutes later. In the duodenum we found some curds of milk which had passed through the pylorus. In the jejunum, for a distance of more than 1 metre, the intestine was full of curds of milk. Artificial opening and pylorus both normal.

Dog 5.—Gastro-enterostomy between the jejunum and fundus of the stomach. After a month, section of the intestine above the anastomosis, closing the gastric end and fixing the duodenal end to the skin.

The next day 400 gr. of milk and hashed meat is given to the dog. After two minutes and a half, milk begins to flow abundantly through the duodenal opening, mixed with a few particles of meat. Ten minutes later about 150 gr. of milk are flowing. The animal is killed 10 minutes after the meal. We find in the duodenum a great quantity of milk and particles of meat which passed through the pylorus. In the jejunum at about a distance of 10 to 20 cm. we see some clots of milk and some particles of meat, representing all that had passed through the anastomosis. Artificial opening and pylorus both normal.

Dog 6.—Gastro-enterostomy between the initial portion of the jejunum and the fundus of the stomach. Thirty days after the operation,

after having removed an adhesion, which united the anterior part of the stomach with a point of the efferent part of the jejunum, situated 9 cm. below the anastomosis, we cut the intestine across above the anastomosis, closing the gastric end and suturing the duodenal end to the skin.

The next day a meal of milk and hashed meat was given to the dog. Seven minutes later, the milk and some particles of meat were passing through the duodenal aperture. The dog was killed half an hour after the meal. The duodenum contained some curds of milk and some particles of meat; the jejunum contained milk and meat in its first centimeter. Gastro-anastomosis and pylorus both normal.

Dog 7.—Gastro-enterostomy between the initial portion of the jejunum and the pyloric antrum. Two hundred and twenty-three days after the operation, second operation (June 22, 1912). Section of the jejunum above the anastomosis, closing the gastric end and suturing the duodenal end of the skin. 20 cm. below the anastomosis, the jejunum is cut through a second time, closing the distal end and fixing the proximal to the skin.

The next day, 100 gr. of milk is given to the dog; 1 minute later liquid begins to flow through the jejunal fistula (corresponding to the anastomosis); 2 minutes and a half later a large amount of bile is flowing through the duodenal fistula. These liquids are collected and preserved. About a quarter of an hour later, the liquid coming from the jejunal fistula is no longer clear, a fresh sample is put aside. These different liquids are analyzed by W. Fabre. During the first quarter of an hour, bile flowed through the duodenal fistula and acid liquid through the jejunal fistula. After a second quarter of an hour, bile was coming through the duodenal fistula, the jejunal fistula giving a liquid containing ozazone (specific of lactose) which W. Fabre could not find in the bile coming through the duodenal fistula. Next day half a pint of milk is given to the dog. It is killed an hour later. The stomach contains an almost clear liquid with some curds of milk; the duodenum is full of bile and some few curds of milk. The piece of jejunum connected with the gastric mouth is full of curds of milk. The mouth is normal, so is the pylorus.

In none of these experiments did we find the mouth obliterated, nor thickened, even after having kept the dog alive during a long time, 223 days in one case.

As for the functions of the mouth, we may leave aside the experiments 1 and 2. In the first, function was prevented by adhesions and angulation; in the second, the dog died the thirty-seventh day in consequence of an intestinal occlusion produced by a bone obstructing the mouth and the intestine just in front of it.

In 2 cases, in which the mouth was made on the fundus, the gastric contents passed at the same time through the mouth

and through the pylorus, but the greatest quantity through the latter.

In 3 cases, in which the anastomosis was made on the antrum, 44, 50 and 223 days after the operation, the gastric contents (milk and meat) passed through the artificial mouth almost entirely.

These experiments show that the evacuation is done principally through the anastomosis if it is situated on the pyloric antrum, through the pylorus if it is situated on the fundus of the stomach.

If previous experimentors saw the gastric contents passing almost altogether through the pylorus, it was probably because of their having made the anastomosis on the fundus of the stomach. It is the fundus which presents when opening the abdomen of a dog, and it is this part of the stomach which is brought out. Therefore, it is the natural portion used for anastomosis. The pyloric antrum, on the contrary, is situated deep under the liver and it is necessary to pull it out to bring it to light. It is, therefore, only when one has the fixed intention of making the anastomosis on this part that one is at all likely to do so.

Most probably Kelling, Delbet and Tuffier operated on the cardiac part of the stomach. As for Tuffier,³⁴ we are quite sure of it. He says: "I remind you how easy it is to observe on a dog, making use of X-rays, that everything passes through the pylorus, because we know, when operating on a dog, that the new pylorus can only be placed at a distance of 25 cm. from the normal pylorus and not less."

In the experiments on cats of Cannon and Blake, 8 times gastric contents was forced out naturally by peristaltic waves through the pylorus; only 2 exceptions were observed, food leaving by both exits; in one of these two cases the stoma was in the posterior wall of the antrum close to the pylorus, in the other about half-way between the two ends of the stomach.

Calabrene, who paid attention to place the mouth near the pylorus, notes that the contents of the stomach pass through the anastomosis.

These different modes of evacuation of the gastric contents, according to the position of the artificial opening, find their explanation in the differences of the muscular contractions in the different zones of the stomach. In order that the gastric contents may pass from the stomach into the intestine, the pressure to which it is subjected must be greater than that of the intestinal contents.

Experiments show us that the pressure, which is very weak in the fundus, gets stronger in the antrum and that even in the latter it is subjected to considerable variations, getting considerably stronger at the very moment of the gastric contractions. Von Pfungen, in 1887, measured intragastric pressure on a boy with a gastric fistula. The pressure in the fundus varied only from 5 to 10 mm.; in the region of the pylorus, the pressure was greatly increased and varied from 40 to 80 mm. mercury, in connection with its peristaltic contractions.

Hofmeister and Schutz had observed likewise a very great difference in the form of contractions of the two parts of the stomach, in their experiments on dogs. Moritz has seen, in his observations on men, that as far as the left part of the stomach was concerned, he observed only very rare and slight variations of pressure, from 2 to 6 cm. of water, meanwhile, he found that in the pyloric region the energetic contractions of the gastric muscle were very frequent, and capable of making the water rise up to 50 cm.

All the investigations agree to make us consider, with Gray and others, that the stomach consists of two parts, the cardiac part acting as a reservoir and the pyloric part as a motor.

One understands, therefore, that the juxtapyloric anastomosis works actively even when the pylorus is normal, and that the anastomosis on the cardiac part is functionless in cases of a permeable pylorus.

Radiological Examinations (in collaboration with Dr. Maingot, radiographer of the Loumec Hospital and Wolfram, junior demonstrator in anatomy).—The radiological examina-

tions on man have confirmed the results of the experiments on dogs. Our anastomoses have almost always been placed on the lowest part of the pyloric antrum. In consequence, we observed that the evacuation of the gastric contents takes place partly through the anastomosis, partly through the pylorus.

To be quite certain of the exact point of passage of the bismuth, the examination of a skiagram is insufficient. In cases where the bismuth has passed through the pylorus, it happens that the skiagram shows a loop leaving the greater curvature and giving the illusion of a passage through a gastro-intestinal anastomosis, whereas this appearance is due to the fact that the initial portion of the duodenum is overshadowed by the stomach, the jejunal shadow only separating from that of the stomach below the greater curvature. It is indispensable to make a skiascopic examination. One then sees the bismuth pouring into the stomach and passing through the anastomosis before reaching the pylorus. In this way it is impossible to mistake the evacuation through the anastomosis for an evacuation through the pylorus.

The evacuation through the anastomosis does not always take place in the same way: On 19 of our patients without a sign of gastric stasis before the operation and no sign of pyloric stenosis during the operation, we observed after intervals varying from 1 to 11 years:

Once, everything passed through the pylorus; 11 times everything passed through the anastomosis; 7 times the bismuth passed both through the anastomosis and the pylorus.

Sometimes, the passage was almost immediate; in other cases the passage took place by instalments, succeeding each other at short or long intervals; in some cases the evacuation began with a gush and continued by repeated instalments.

The results of radioscopic examinations are therefore in accordance with the results of the experiments and show that, in opposition to the general opinion, the gastro-intestinal anastomosis may work even in cases where the pylorus is patulous.

We have found these results interesting enough to draw your attention to them even if they have not considerable practical importance and if they do not prevent many surgeons from continuing to exclude in many cases the pylorus.

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CHRONIC PANCREATITIS.*

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As a direct object of surgical attack the pancreas remains to-day the most unpromising of all essential organs. Complete removal is homicidal, partial excision is difficult and but rarely indicated by the character of its diseases, and direct drainage can be accomplished only in very imperfect fashion at best. In the past few years much has been added to our knowledge of pancreatic disease, its frequency and its pathogenesis. As surgeons we should derive some therapeutic gain. It is in the hope of clarifying our position in respect to chronic pancreatitis that we offer these brief observations.

Our difficulties in dealing with chronic pancreatitis are greatly increased by the fact that we possess no definite syndrome of signs, symptoms or laboratory tests by which an early clinical diagnosis can be made and the situation is further complicated by the existence of the disease in two chief forms, one of which involves particularly the interlobular septa and the parenchyma of external secretion, while the other attacks chiefly the islands of Langerhans and only in lesser degree the secretory tubules and interlobular structures. In the interlobular form of the disease digestive symptoms predominate. In disease of the islands of Langerhans, as is well known since the researches of Opie, disturbance of carbohydrate metabolism results, manifesting itself in the more pronounced cases as diabetes. Both these processes when clinically recognizable and demonstrable are characterized pathologically by parenchymatous degenerations of advanced degree and the deposit of fibrous tissue and fat in the gland.

* Read before the American Surgical Association, April 9, 1914.

When this state of affairs is present it is useless to expect cure in the sense that the damage done may be repaired or even compensated for in any marked degree. It is quite comparable to chronic nephritis of the type characterized by deterioration and degeneration of the renal cells with interstitial fibrosis. Partial or complete arrest of the process may at times be effected by removal of the cause of the disease or by careful palliative treatment along empirical lines. But for practical purposes we may consider such cases as having acquired a chronic condition that will necessitate at best a degree of invalidism and in general will sooner or later, directly or indirectly, be responsible for the death of the individual so affected. We have on a number of occasions had the opportunity of reopening the abdomen in a case the subject of chronic indurative pancreatitis and in no instance have we witnessed a return to a normal condition. We have also operated upon a number of cases of diabetes in which there was good reason to believe that the process was inaugurated by inflammation of the biliary passages. In no case of well established diabetes did a cure of that condition result, so far as we are able to determine. On the other hand, transient glycosuria, present during exacerbations of biliary and pancreatic disease, we have seen entirely relieved by appropriate operative treatment of the underlying condition. These experiences clearly point the lesson that treatment of the chronic form of pancreatic disease must be directed at the early stages if it is to be effective. We must prognosticate the probable course of early lesions and act with promptness in order to prevent their development.

Owing to the inaccessibility of the pancreas and the difficulties of observation, the slow transitional gradations from early lesions to late effects have never been followed in the individual, nor has a complete series of changes been compiled by the pathologist because of scantiness of early material, and the difficulty of study of finer parenchymatous changes, owing to the self digestion of the organ which begins probably in the agonal stage and rapidly proceeds in the first few hours after

death. We must, therefore, have recourse to deduction based upon operative findings, clinical experiences and, only to a lesser degree, upon the late findings of the mortuary.

Several facts have been established. First, a very considerable proportion of pancreatic inflammation is associated with, and in all human probability secondary to inflammatory lesions of the alimentary tract and its derivatives. The biliary tract and the duodenum head the list by reason of their contiguity. There is reason to believe that the stomach, the appendix and possibly the colon and remainder of the intestine may at times be primarily responsible.

The second fact of importance and one which has been repeatedly verified is the common involvement of the head of the pancreas and the relative immunity of the body and tail of the organ in inflammations transmitted to it from an inflamed biliary tract or duodenum. As we have pointed out previously, this behavior does not square with the current conception of the pathogenesis of pancreatitis, namely, that it is in the majority of cases a duct borne infection. It is difficult to conceive of an infection of the ducts which could so generally select but one portion of the duct distribution as its seat, to the exclusion of the other areas communicating just as freely with the terminal ducts of discharge. Would we not rather believe on anatomical grounds that the head of the pancreas would show the lesser lesions, since in a considerable proportion of cases it possesses an additional functionating path of discharge of its secretion through the duct of Santorini, which can in no way be affected by what has been aptly termed the "unfortunate association of terminal facilities" of the duct of Wirsung and the common bile duct?

A better explanation of the early pancreatic swellings and inflammations seen at operation exists in the close association of the lymphatics of the gall-bladder, the liver and the duodenum with those of the head of the pancreas. In former communications we have described the lymphatics leading from the gall-bladder, the bile ducts and the duodenum in their relation to the head of the pancreas where they anastomose inti-

mately with the lymph-vessels of that organ. We have observed clinically indications of the march of the infection most typically in cholecystitis where, in sequence, we have found the inflamed gall-bladder, enlargement of the cystic lymph-gland, infiltration of the gastrohepatic omentum, hyperplasia of the glands about the common duct, peripancreatic infiltration and enlargement of the head of the pancreas. We have shown that the areas of pancreatic infection correspond with the lymphatic distribution and not with the duct distribution. For this condition we have adopted the term pancreatic lymphangitis, proposed by Arnsperger, and have suggested that the condition probably is, in a percentage of cases at least, the forerunner of the alterations characteristic of chronic pancreatitis.

This condition occurs with cholecystitis with or without stones. It is, so far as we are aware, undiagnosable, except by direct inspection and palpation at operation. It cannot, therefore, be regarded as an indication for operation except in the cases characterized by more persistent and severe exacerbations.

Our knowledge of the existence of this condition must affect our ideas of treatment in two ways: First, in emphasizing the necessity of prompt and radical treatment of abdominal diseases, particularly those of the gall-bladder, which do not yield readily to internal measures; second, in influencing our operative procedures in cases where this condition is present as a complication during operation. A recent instance of the disasters of delay in cholecytic disease is the following:

The German Hospital, white, female, thirty years old. Pain in epigastrium and back. Since July, 1913, has had nine attacks of very sharp pain, beginning between shoulder-blades, radiating front to gall-bladder area, relieved by morphia. Each attack lasts about one week, followed by soreness in upper abdomen and jaundice. March 23, had a severe attack of this pain, with chills, fever, and collapse, and uncontrollable vomiting, followed by jaundice the following day. Pain and jaundice have persisted.

Bowels have been regular. Stools have not been clay colored. Micturition normal, but the urine is very dark.

One child four months old. Menses just beginning. Appendicitis six years ago—not operated. Abdomen: palpable enlargement in epigastric region, extending into gall-bladder region.

Operation (April 1).—Findings: extensive fat necrosis and acute suppurative pancreatitis; pus confined to lesser peritoneal cavity.

Blood Count.—Polynuclear neutrophiles, 87; lymphocytes, 7; leucocytic mononuclears, 9; haemoglobin, 70; red blood cells, 4,180,000; white blood cells, 27,750.

Test Breakfast.—Free HCl, 41; total acidity, 90.

Cambridge "C" Reaction.—Negative. Culture pus pancreatic. Collection, no pus.

Stool.—Occult blood: Ft. positive to benz.; negative to guaiac. Bile: vert ft. positive.

The effect of our knowledge of the dissemination of infection by way of the lymphatics has been to diminish our faith in simple drainage of the gall-bladder or ducts as a cure-all for biliary and pancreatic infection. It is well known that there is a percentage of recurrences of biliary infection after drainage operations. This is more common in simple cholecystitis than in calculous disease of the gall-bladder or ducts. In a considerable number of cases obstruction of the cystic, common or hepatic ducts seems to play no part. At least there is no evidence of obstruction in the shape of a demonstrable cause or in dilatation of the ducts by back pressure. In such cases, however, mucosal and interstitial infection of the wall of the gall-bladder may be present. If it is not dependent upon intermittent or constant obstruction for its foothold it is not likely that freer drainage will completely dislodge it and it is in these cases that our operative results have proved most unsatisfactory from the stand-point of permanent cure. It is true that some cases are cured and the majority benefited temporarily by simple cholecystostomy, and reasoning along these lines it has been proposed to do cholecystoduodenostomy, -gastrostomy or -enterostomy in cases complicated by chronic pancreatitis, with the idea of providing permanent free drainage. Unfor-

tunately for the idea it has been found that such a fistulous opening does not remain permanent in the absence of an obstruction to the natural course of the bile. There is but one course open, therefore, which is the removal of the gall-bladder, in which, as a rule, the lurking place of the infection is found. While for years we defended cholecystostomy and decried cholecystectomy except for the most evident indications, we have come to believe that the field for cholecystectomy should be widened and that all gall-bladders should be removed that show evidence of chronic infection independent of obstruction and particularly so if the pancreas is involved. We believe also that in calculous cholecystitis, which shows evidence of marked interstitial disease and disseminated lymphangitis the chances of permanent cure are enhanced by cholecystectomy.

Naturally in each case good surgical judgment will weigh the increased immediate danger of an operation of greater magnitude against the question of permanence of results. In suitable cases with good technic we do not believe that the danger will be much, if at all, increased by cholecystectomy. Such has been Kehr's experience. In this country cholecystectomy has had a distinctly higher mortality, which is due chiefly to the fact that it was reserved for more serious and complicated cases. Still, in the presence of great operative difficulties or when dealing with a poor surgical risk, we would not advocate cholecystectomy for these indications, since simple drainage cures many and it is our creed, frequently stated, that a living patient after two operations is better than a dead patient after one thorough operation.

Another point of great importance is drainage of the common duct in connection with cholecystectomy. This is best done with the T-tube. It should never be omitted for the reason that it greatly diminishes immediate danger and renders recurrence less likely. We always run a risk of misinterpreting the basic lesion and we are not willing to discard the known benefits of drainage in so many cases. It is possible also by choledochotomy to pass a searcher into the ducts and down into the duodenum and thus dismiss the possibility of stone or

stricture. There is a group of obstructive cases in which the only cause that can be found is stenosis of the papilla of Vater. Whether this is due to a spasm of the sphincter of Oddi or to inflammatory changes in the tissues surrounding the orifice is not definitely known in all cases. Certainly many are inflammatory and particularly those cases of complete and lasting obstruction associated with jaundice cannot be interpreted as sphincterismus. It seems not unlikely, however, that spasm of the sphincter does occur and is productive of symptoms. Divulsion of the papilla by a large searcher or gall-stone scoop is curative in these cases. When the gall-bladder is removed we must realize that we are taking away the "tension bulb" of the biliary tract, the mechanism by which transient back pressure is prevented from exerting its full effects upon the liver directly. It is of paramount importance, therefore, to be sure that nothing exists in the nature of an obstruction to the free discharge of bile into the duodenum. Slight or intermittent obstruction at the papilla is not sufficient to enable the surgeon to recognize the condition by the appearance of the common duct and it is therefore wiser to eliminate it in the manner here suggested.

Finally, it must be said that the most important message that the surgeon has for the profession, as the result of the increase of knowledge of pancreatic disease made possible by the autopsy *in vivo*, is the necessity of referring intractable dyspeptics to the surgeon. It is not enough that the internist by diets, drugs and trips to Carlsbad, French Lick Springs and the like can lull infected gall-bladders and ulcerated duodenum into temporary quiescence. If by recurrences and chronic disturbances it is evident that sterilization of the infected area has not been accomplished, he should realize that he is exposing his patient to the most serious damage to the parenchyma of essential organs which can never be repaired.

SUGGESTIONS REGARDING THE ANATOMY OF AND THE SURGICAL TECHNIC IN THE TREATMENT OF JONNESCO'S MEMBRANE.*

BY JOHN E. SUMMERS, M.D.,
OF OMAHA, NEB.

IN a paper which I read before the Surgical Section of the American Medical Association at its last meeting in Minneapolis, entitled "Surgical Aspects of Intestinal Stasis, from an Anatomic Point of View," I asked discussion upon the following points:

1. If the Jonnesco-Jackson-Reid membranes are congenital, are they always more or less clearly demonstrable in every individual, should the incision admit?
2. Are the membranes purposive? If so, are they not intended by nature as ligamentary supports—preventive of intestinal stasis rather than causative?
3. Therefore they should be divided only after they have become restrictive of intestinal function, from loss of nervous and muscular tone resulting from chronic intestinal toxæmia.
4. Is the method of demonstrating the so-called "white line" always reliable? If so, does not this in itself prove the congenital origin of the membrane and its physiologic importance?

I believe that every thinking, informed man to-day should concede that all of these membranes are congenital; the demonstrations by Flint, Rilus Eastman, and others, clearly show this, and I have had so much personal corroborative evidence that these membranes can be demonstrated to a greater or less degree in every abdomen when the incision admits of a thorough inspection, that I am no longer in doubt as to this, to me, established fact, and many of my friends are agreeing with me—some of them men of the widest experience in abdominal

* Read before the American Surgical Association, April 9, 1914.

surgery. As Sir Arbuthnot Lane in one of his papers writes, "acquired mesenteries and adhesions," as he is pleased to call them, "were absolutely and categorically denied by physicians experienced in post-mortem work, who appeared to think that, because they had escaped their observation as many things have done and will continue to do, they were justified in denying their existence in the most dogmatic manner possible." Many of these friends of mine who now agree with me as to the position that I take in this matter, formerly smiled, if they did not disagree. Now that they are looking for themselves they see with the same eyes that I do. The study of anatomy at the operating table has impressed me more and more, that the viscera of men differ in as great a degree as do their faces—there are no two exactly alike.

If the Jonnesco-Jackson-Reid, etc., membranes are congenital and always more or less clearly demonstrable, then they *must* be purposive and intended by nature as an aid in carrying out the function of the bowel, and it is only when the arrangement of these membranes is at variance with the conduct of the normal function of the bowel, that the membrane becomes pathological, and this arrangement may be defective or restrictive—defective when the bowel is not properly supported, restrictive when its function is restrained or inhibited. Neither of these conditions is apt to be observed in childhood. The muscular tone is so positive in childhood and youth that the peristaltic action of the intestine overcomes minor difficulties. It is only when this tone, from physical conformation of the skeleton, habit, or long continued over-strain, becomes lessened, that a too loosely supported bowel or a too tightly restricted bowel is unable to functionate without the development of more or less intestinal stasis with its accompanying symptoms. As Mr. Gray puts it (*British Medical Journal*, January 24, 1914), it is the *manner* of attachment of the membranous bands to the bowel or its mesentery that causes stasis. I have seen the so-called Jackson-Jonnesco membrane in a considerable number of individuals under twenty years of age, but have never seen symptoms produced in any one under

seventeen years of age. Van Buren Knott tells of two infants under one year of age, with most extensive Jackson membranes, upon whom he successfully operated for intussusception, the Jackson membranes having nothing to do with the cause of the intussusception, and the infants being in good health succeeding the operations, with normal bowel function. Most of the cases that I have observed where abdominal symptoms were dependent upon *defective* or excessive envelopment of the bowel in a so-called Jackson membrane, were in people over thirty years of age, and in several they have been between fifty and sixty years of age. The intestinal wall loses its tone just as the bladder may lose its tone from the various causes that produce it. Therefore, two lines of procedure may be required for the relief of intestinal stasis and the accompanying symptoms—the *one* to release the bowel so as to permit of freer function, the *other* to support the bowel, thereby increasing its muscular tone. In excessive angulations from membranous restrictions it may be advisable to relieve the resulting stasis by an exclusion of the colon. I am not as yet prepared to admit the justifiability of its excision. Even without angulating bands involving the cæcum and lower ileum, stasis in the ileum may be demonstrated as caused by an incompetency of the ileocolic valve. J. T. Case (*Medical Record*, March 7, 1914) has found by X-ray observation 250 cases of this kind in an examination of 1500 people in whom the competency of the valve was tested by the bismuth enema, and Kellogg (*Surgery, Gynecology and Obstetrics*, November, 1913) has reported a number of patients successfully operated upon for stasis of the lower ileum, the result of damming back from the colon because of incompetency of the ileocolic valve. So it is again seen that congenital membranes and bands of the right iliac fossa may in themselves be innocent of mechanically causing auto-intoxication. As Kellogg says, "the remarkable advances made in the technic of the X-ray study of the alimentary tract within the last few years, have rendered invaluable service in making it possible to locate the cause of obstruction in these obstinate

cases." Further experience has convinced me that the so-called "white line," which I believe to be the line of fusion of the duodenal and colonic peritoneum with the parietal peritoneum after rotation of the duodenum and colon has been completed, is always demonstrable whenever the pericolic membrane can be shown, and it is the line of attachment of the pericolic membrane to the parietal peritoneum. It is demonstrated by rotating the attached hollow viscus in a direction continuous with the course of the blood-vessels and fibres of the membrane. I have called this "white line" the *ligamentary attachment* of the pericolic membrane to the parietal peritoneum. Usually, when it may be deemed best to release the intestine from the investment of this ligamentary support—the pericolic membrane—it should be divided along its loosest line of attachment; however, greater motility may be obtained in some instances by dividing the membrane at its base—the "white line"; when this line is short, as it frequently is in the hepatic region, the raw space, left by the division of the line in the direction with its course, can be closed by suturing at a right angle to the line of division. If the "white line" is a long one, as it sometimes is in an extensive membrane enveloping the ascending colon, this is not practicable. When, in addition to the presence of a Jackson membrane, there is a marked ptosis of the hollow viscera, particularly the cæcum and transverse colon, the membrane should not be divided, but some of the methods advocated by Coffey and Connell are indicated. I have found, however, in women, that a properly fitted, front-lace, straight front corset, will relieve many of the symptoms that depend upon these ptoses, provided proper habits of life are observed.

BULLET IN THE PERICARDIUM.

AURICULAR FIBRILLATION.

BY GEORGE E. ARMSTRONG, M.D.,

OF MONTREAL.

THERE was admitted to the Royal Victoria Hospital, Montreal, on Feb. 17, 1913, an Italian, aged 46, complaining of a wound in his chest.

He says that he was treated for pneumonia in this hospital nine years ago. He has taken alcohol very freely.

He stated that at 5 A.M. on the day of admission he was shot by his son. The assailant used a 32 calibre revolver and stood in front of him and about five feet away. The patient says that he was dazed for a moment and then recovered and pursued his assailant, but was unable to run far on account of weakness.

He is a well-developed, well-nourished Italian. He can assume any position, complains of but little pain. There is no respiratory distress. His general condition is good. Pulse regular and not rapid. There is a small punctured wound opposite to the third intercostal space and slightly to the left of the border of the sternum. There is no staining or charring of the skin and but little tenderness on pressure. There is no discharge from the wound and very little discomfort on taking a full breath.

The chest is emphysematous, but there is no evidence of pneumothorax or of air or blood in the pericardium. No murmurs can be heard nor any friction rub. An examination of the abdomen was negative. In the afternoon the pulse became irregular, missing every fourth to tenth beat.

A fluoroscopic examination of the chest showed the bullet lying loose in the pericardium, moving with each heart beat, and changing its position with the changing position of the patient. If the man lay on his right side the bullet rolled to the right, and back again to the left when the man rolled on his left side. The bullet seemed to lie most naturally toward the right. Marked irregularity in the pulse developed when the patient was moved frequently from one side to the other. In the late afternoon a slight cough developed.

During the succeeding four or five days, the only changes to be noted were increasing irregularity of the pulse and a change in his general condition. It was evident to everyone that the man was losing ground. The temperature elevation was not great, a hundred and two-fifths was the highest. The change in the pulse was definite. It became more rapid, more irregular, and smaller and more compressible. Two physicians, Drs. Martin and Hamilton, saw him with me daily and the different views soon took definite form and largely on one issue. None of us had had any experience in similar cases to guide us. The important question at the moment was, Should the bullet be removed or not? The physicians inclined to the view that the bullet had done its work. That there was, very likely, an injury to the heart, either to the auricle or to the ventricle or the auriculoventricular groove, but that the bullet now lay free in the pericardium and that it was a matter of no importance whatever to the patient whether the bullet was removed or not. Against this theory was the daily, progressive, general failure in condition and the increased rapidity and irregularity of the heart's action. The proposal to remove the bullet was finally assented to on the ground that he would be no worse afterward and might be better. A tracing showed complete auricular fibrillation.

A radial tracing showed an irregularity both in volume and rhythm; the figures under each pulse period indicate the duration in seconds. Lime marker in $1/5$ seconds.

On comparing the radial with the venous tracing it can be seen that the irregularity is not due to extra systoles. There was a marked and rapidly irregular pulsation of jugular veins in the neck. The venous tracing is of the so-called ventricular type, showing the same irregularity as shown in the radial with an utter absence of any wave due to auricular contraction. The carotid and "V" waves are the only waves represented.

This combination of an absolute irregularity and absence of any sign of a regular and definite auricular contraction can be due to only one condition, viz., auricular fibrillation.

In the afternoon of the fifth day I removed the bullet. Ether was administered by the intratracheal insufflation method.

Wilm's intercostal incision through the fourth intercostal space brought me readily down upon the pericardium. The internal mammary artery was divided between two ligatures. The pleura

was opened and the lung allowed to collapse moderately. A rib-spreader was inserted and the pericardium opened. I now passed my finger within the pericardium but could not feel the bullet, although the patient was rolled from one side to the other. A portion of the fifth rib was resected and I could then pass two fingers in and feel the bullet lying directly behind the heart. By rolling the patient well over on his left side the bullet came readily within reach of my fingers and was hooked out. There was little blood or effusion in the pericardial sac.

The opening in the pericardium was then closed with catgut sutures without drainage. A little increase of pressure in the intra-tracheal apparatus brought the lung out to the level of the incision in the chest wall, which was then closed, leaving very little if any air in the pleural cavity.

Throughout the operation for the removal of the bullet the pulse retained the same characteristics and a rate of 130 to 140, varying slightly throughout the anaesthesia. After the bullet was removed and before the pericardium was sutured the pulse obviously quieted and the rate was 120 at the carotid.

Two and a half hours after the operation the pulse was 105 and perfectly regular.

A tracing taken the same morning showed what to all intents and purposes was a normal tracing, a well-marked and large auricular wave and a large onflow wave.

The radial tracing was regular in volume and rhythm and showed a rate of 90 per minute.

CONCLUSIONS.

1. Onset of auricular fibrillation in a heart where, as far as could be ascertained, there had been no previous inflammatory mischief, no symptoms of any cardiac involvement, due to the presence of a foreign body.
2. Cessation of the disorderly rhythm on the removal of the cause—the bullet.
3. A rare opportunity of observing the heart in such a rhythm.

We have been unable to find any reference in literature to a similar condition.

PULMONARY ABSCESS AND BRONCHIECTASIS.*

A CLINICAL REPORT.

BY HOWARD LILIENTHAL, M.D.,

OF NEW YORK,

Attending Surgeon to Mt. Sinai and Bellevue Hospitals.

SINCE the application of intratracheal anæsthesia to the human being early in 1910, with the simplification of differential pressure methods in endothoracic operative work, I have been greatly interested in the new possibilities of lung surgery. Believing that there is a peculiar interest and value in studying the methods and results of an individual surgeon, I venture to offer a series of histories and notes representing my own work since 1910 in cases of lung abscess and bronchiectasis.

There have been a number of other thoracic cases, but I have limited this paper to a consideration of the suppurative non-tuberculous lung infections.

There were fourteen operations on eleven patients, and there were but three actually "*cured*." Two cases are still unfinished and cannot be included in my table, though I present abstracts of their histories. One patient was not operated upon.

Five operations were followed by visible improvement, and there were four deaths.

Two of the fatal cases (VI and VII) I consider to have been hopeless. One of the other two might have survived for a time (Case II) had I been satisfied with a mere "operative" recovery. Case VII might perhaps have recovered with better technic.

Of the eleven patients operated upon five had bronchiectases and of these one patient died in the hospital. The others were more or less improved. One died about a year later of hemorrhage.

* Read before the American Surgical Association, April 10, 1914.

There were three cases of acute abscess and two of the patients recovered.

One of chronic abscess recovered.

One of acute extensive gangrene died.

One of fetid bronchitis with minute abscesses died.

Hemorrhage (haemoptysis) was prominent in four of the bronchiectatic cases, and in these resections of the thorax certainly did result in benefit, in two of them the tendency to hemorrhage having been temporarily checked. Indeed, obviously insufficient operative attempts were several times followed by decided improvement, both subjective and objective (lessening of the amount of expectoration).

Clubbing of the fingers was a prominent phenomenon in the chronic cases, the appearance even in little children being most striking (see Fig. 1).

In trying to arrive at an exact differential diagnosis of chronic intrapulmonic suppurations it must be remembered that as a working rule all may be regarded as "lung abscesses." A lung abscess may begin outside the lung itself, as, for example, in an empyema, and the secondary abscess may even drain itself through a bronchus. Occasionally the radiograph may show a level liquid surface-line with clear space above and opacity below (see Fig. 2). But when it comes to the operation we must be prepared for surprises.

The surgeon must possess that quality of mind known as *imagination*. He must have the faculty of producing a distinct mental image showing, as it were, the physical characteristics of the object with which he has to deal. He must have in his mind a picture of the morbid part formed with the help of all the diagnostic aids at his command—and at the same time he must keep an open mind and change his preconceived idea and also his plan of action as the progress of the operation or of the disease indicates previous error.

Although bronchoscopy was practised in but two of the cases in this list, I have had the advantage of this important diagnostic aid in several other cases and shall employ it when feasible whenever a pulmonary operation is contemplated.

In addition to the possibility of finding an unsuspected foreign body some points of pathological anatomy can be cleared up with a certainty at least as great as that achieved in urological cases by cystoscopy.

My attempts at cure by operation were: Thoracotomy and drainage.

Thoracoplasty for reducing the capacity of the affected side.
Extrapleural tamponade (Tuffier).

Extirpation of the affected part of the lung.

I have been surprised in some of my cases, especially those of bronchiectasis, at the tremendous toughness, thickness and rigidity of the inflammatory tissues surrounding the diseased focus. This point alone is enough to convince one of the futility of treating these cases by artificial pneumothorax and to make one doubt the efficiency in indurated bronchiectasis of Tuffier's method of extrapleural plugging, which he has so successfully employed in apical tuberculosis.

Briefly, this operation consists in the careful digital dissection of the unopened apical pleura from the endothoracic fascia through an intercostal incision; the forcing downward of the entire apex compressing the lung tissue so as to leave a great hollow where the apex was; then the implantation of living tissue, either fat or benign tumor substance, so as to fill completely the dead space; finally, the closure of the wound by suture. I would suggest as a name for this ingenious operation biotamponade—or if fat is used, lipotamponade.

In old cases of fetid bronchiectasis with the usual mixture of bacterial strains and with intimate adhesion between the visceral and parietal pleuræ, there is a very real danger of infecting the tissues surrounding the newly made extrapleural cavity even without breaking into the septic focus. This danger is obviously less when we are dealing with a pure tuberculosis.

The two-stage operation in certain forms of true lung abscess may be an advantage. At first the free pleural cavity is opened, inspected and palpated, and the extent and character of the disease ascertained. A few days later the drainage

operation may be undertaken with increased accuracy and better chances of success. The general pleural cavity can be well protected, even in the neighborhood of suppuration (see Case VIII and Case IX).

If the operation is to be performed with a view to resection of the diseased lung, however, one sitting is best.

Differential pressure, however attained, is a valuable aid in chest surgery, but it must be understood that most of the commoner operations upon one lung can be done with anæsthesia managed in the ordinary way.

No major work through the thoracic cavity should be undertaken without full narcosis.

Anæsthesia by intratracheal insufflation has been a great comfort in many of these cases and its application tends to become simpler. Still, in spite of the beautiful, almost automatic, character of this method of anæsthesia it is far from "fool-proof," and there should be the most scrupulous attention to details. The apparatus must be tested immediately before using it. A supplementary bellows must be at hand in case the electricity fails, a woven trachea tube of proper size ($\frac{1}{3}$ to $\frac{1}{2}$ the calibre of the trachea) must be selected and inserted under the guidance of the eye. During the entire operation the air pressure and the strength of ether mixture must be carefully observed. Even when everything is running smoothly and the patient's color is good the pressure should be completely shut off for a few seconds every minute. And there are a number of other points which it is not necessary to mention here. However, the technic is not difficult to acquire and it can be well studied by experiment in the ordinary run of surgical cases in which the differential pressure element is not an essential factor.

REPORTS OF CASES WITH CRITICAL REMARKS.

CASE I.—*Bronchiectasis.* B. F. Exploratory thoracotomy in intratracheal anæsthesia.

The history of this patient has been reported and may be found in the *ANNALS OF SURGERY* for July, 1910. It was the first

case in which thoracotomy in a human being had been performed with the aid of intratracheal anaesthesia. The disease had been characterized by the usual profuse expectoration and by severe attacks of pulmonary hemorrhage. The operation was an exploration which revealed the site of the tough adhesions in the right subscapular region (indurative bronchiectasis—Hoffmann). The hand within the thorax, aspiration through the sound chest wall was practised but the abscess could not be found by this means. For some reason improvement followed this insufficient operation but the patient died of a hemorrhage a few months later.

CASE II.—Bronchiectatic abscess; thoracoplasty; infection of opposite lung. Death.

I. B., a boy of nineteen was referred to me on August 11, 1911, by Dr. James A. Miller, from his service at Bellevue Hospital.

Eight months before his illness had begun with pain in the right chest, cough and fever. No tuberculosis.

When he came to me he was in good general condition though there was some cyanosis. His breath was very fetid and there was a daily expectoration of eight ounces, the patient often vomiting from his cough.

The pulse was normal, the temperature rising at times to 100°. Over both chests were numerous moist râles but the right base appeared to be most involved. Below the tenth rib posteriorly on the *left* side there was impaired resonance.

A radiograph by Dr. Hirsch disclosed a shadow representing the diseased area in the right chest.

Operation.—On August 17, 1911, at Bellevue Hospital, the patient in ether anaesthesia, I resected two inches or more from the seventh, eighth, ninth, and tenth ribs, my incision being parallel with the border of the latissimus dorsi muscle. The pleura was not violated.

While this operation did not diminish the quantity of sputum, its character changed and became non-odorous and more mucoid. The temperatures ranged about 99° F.

In March, 1912, the patient entered Mt. Sinai Hospital for further treatment because of repeated severe hemorrhages.

An X-ray picture at this time showed some clearing of the former shadow but there was opacity in the right base up to the ninth vertebra. The general condition and weight had improved

greatly after the operation but had then deteriorated. Expectoration about four ounces a day.

On April 12, 1912, I removed large sections of the second, third, fourth and fifth ribs in the axillary line, the anæsthetic being ether administered by intratracheal insufflation. The patient's color remained excellent during the anaesthesia, but directly afterward there was deep cyanosis continuing for some hours. For about two weeks there seemed to be improvement but the left lung became acutely infected and he died on May 16. Unfortunately no autopsy.

Critical Note.—Another discouraging case. The question comes up as to the possible influence of the intratracheal insufflation in the appearance of the acute process in the left lung, although it must be borne in mind that this lung was far from normal from the beginning. Still, the second operation under the insufflation was no more severe than the first in ordinary anaesthesia. Perhaps the tube was too large in spite of its careful selection. That injury to the lung can occur from intratracheal insufflation is well known, though a proper sized tube and attention to details of pressure with periodic collapse of the lungs should make the accident a rare one.

CASE III.—Bronchiectatic lung abscess; resection of ribs and attempted drainage. G. R., thirty years old, had been sick for nine weeks with pain in the right upper chest, cough, profuse and extremely fetid expectoration, fever, vomiting, one chill, and night sweats. There had been much loss of weight and three slight haemoptyses.

He was referred to me by Dr. James A. Miller, who stated that the case was very probably non-tuberculous, a number of sputum examinations having been negative.

The blood showed 18,000 leucocytes with 90 per cent. polymorphonuclears.

On February 6, 1912, he was admitted to Mt. Sinai Hospital.

There was fetid expectoration amounting to about 200 c.c. in twenty-four hours. Cough and expectoration occurred at once when the patient lay upon his left side. There was dulness in the right posterior chest from about two finger breadths below the angle of the scapula. Prolonged expiration at the upper level of the dulness with harsh breathing and coarse sonorous and sibilant râles below this point.

Radiography showed an opacity in the right upper chest reaching almost to the apex of the right lung but not entirely obliterating the normal transparency at this point. The opacity was as large as an adult human palm.

Dr. Miller stated that he had aspirated the suspected area and had secured a few drops of thick mucopurulent material.

On February 16, in intratracheal anaesthesia with ether, an incision was made along the border of the latissimus dorsi, beginning almost at the apex of the axilla. Sections of the third, fourth and fifth ribs were removed here and the chest opened. The pleura was free everywhere except posteriorly and the area above indicated where there were dense adhesions. The lung and parietal pleura were united by a running catgut suture, except posteriorly where the adhesions existed. A large aspirating needle was then plunged repeatedly into the indurated mass but failed to reach a pus cavity.

About six days after this operation I punctured the site of the supposed abscess a number of times through the wound. The result was persistently negative. The patient, however, continued to improve, expectoration amounting to less than 200 cubic centimetres in twenty-four hours and there was an increase of seven pounds in weight. On March 20 he was discharged from the hospital, the wound healed. His sputum then amounted to 100 cubic centimetres in the day. He was subjectively and objectively improved.

Note.—There is nothing remarkable about this case unless it be the fact that as in Case I an insufficient operation was followed by unexpected improvement. I proposed further surgery to this patient but he regarded his condition as tolerable and therefore he refused.

CASE IV.—Bronchiectatic abscess; thoracotomy and drainage; multiple rib resection. On December 17, 1912, this patient, Harry G., twenty-three years old, was transferred from the medical service of Dr. Manges at Mt. Sinai Hospital. He had been ill for six months with cough and profuse foul expectoration—always more abundant in the morning. There had been eight haemoptyses, much blood being lost each time. There were occasional slight attacks of fever.

On physical examination, there was dulness with hard breathing and inconstant "sticky" râles in the right axilla. The patient

had clubbed fingers. His general condition, however, was excellent as to nutrition and musculature.

The temperature was normal, the pulse 80 and the respiration rate 24.

A radiograph made by Dr. Jaches, on December 7, 1912, revealed a sharply defined, oblong shadow opposite the base of the heart, with a prolongation upward and outward. There was also a narrow shadow passing downward and outward (see Fig. 3).

Operation.—On December 20, 1912, in intratracheal anaesthesia, an incision was made parallel to the fibres of the latissimus dorsi muscle in the right posterior axilla. A four inch section of the fifth rib was removed and an attempt was made to enter the pleural cavity. Adhesions all about, however, showed a complete walling off. A section of the fourth rib was removed, also without entering the general pleural cavity, and a needle puncture withdrew a small quantity of fetid pus. A narrow opening was made with the scalpel and then with dressing forceps the extremely tough and dense membrane surrounding the abscess itself was torn apart, the dressing forceps on withdrawal widening the opening into the cavity. Explored with the finger there were evidently many loculi and the case one of bronchiectatic abscess. But little pus escaped at this time. The abscess was very deep and lay next to the anterior chest wall. The entire wound was now packed with gauze and the patient sent back to bed with the intention of subjecting him to further operation at another time. The anaesthesia had been excellent throughout, although some blood and pus had appeared at the patient's mouth during the operation.

Ten days later the patient was anaesthetized in the usual manner with nitrous oxide and oxygen and, in the hope of reaching the bronchiectasis more directly, about two inches of the fourth rib were resected at its anterior inner portion. To my surprise, upon incising the chest at this point I found that I had invaded the free pleural cavity. It was quite clear that the former operation had drained the abscess as far as was possible, so the opening in the pleura was packed and the remainder of the wound was sutured. A tube was later placed in the abscess cavity and suction maintained with the apparatus referred to in Case IX. The patient's condition now improved every day but he still daily

expectorated from three to five ounces, the only difference noted being that the discharge was less purulent and more mucoid than it had formerly been.

The wound healed and the patient was sent to a convalescent home. His general health was good but the cough and expectoration for which he sought relief had been influenced but little.

Nearly a year after the first operation this man presented himself again, saying that he was unable to work and that the foul discharge from his lungs made him so miserable that he was willing to submit to anything rather than continue as he was.

On November 21, 1913, in ether anesthesia by inhalation, I removed sections from the fourth, fifth, sixth, seventh, eighth and ninth ribs through a long posterior incision. The inner bone-sections were made just to the spinal side of the costal angle and the amount resected was about two and one-half inches from each rib. The pleura was not injured. The wound was closed by suture with tube drainage above and below. While hemorrhage had been free it was not near the danger line. The chest wall was thoroughly strapped so as to approximate the cut ends of the ribs and reduce the size of the thoracic cavity.

Another examination of the sputum was negative for tubercle bacilli. A culture by Dr. H. Plotz, of the Pathological Laboratory, showed bacillus mucosus capsulatus and from this a vaccine was prepared and given. Highest dose one billion. The patient thought he noted improvement following this therapy. There was now steady progress but by no means a cure. The patient's general condition was very good and his "emptyings" occurred usually but once a day—in the morning. The discharge was not as foul as it had been and the quantity was seldom more than three and one-half ounces.

The case is not yet finished and I hope to improve his condition still further, perhaps by completing the Wilms's operation, resecting the ribs anteriorly, or possibly by attempting the extirpation of the well localized lung infection.

Because of recent published experiences and because Dr. Yankauer had found and removed an unsuspected foreign body from the bronchiectatic cavity of an old man in one of the medical services at Mt. Sinai, H. G. was bronchoscopied before his discharge from the hospital but nothing was found. The diagnosis of bronchiectasis was, however, confirmed.

A glance at the photograph (Fig. 4) gives an idea of the man's general condition and also shows the degree of deformity produced by the operation. The X-ray (Fig. 5) shows the collapse which was attained.

Note.—I am by no means proud of this result even though it compares favorably with many of those reported in recent literature. If we ever are to accomplish anything like an actual cure in these almost hopeless cases it will be by means of direct surgical attack with the actual removal of the bronchiectatic mass.

CASE V.—*Bronchiectatic abscess; transpleural drainage.* A. S., a woman of twenty-six, had been well until March, 1912, when she had "pneumonia" followed by left empyema for which she had been operated upon in another hospital. She had been sent home "well" but there was a relapse and a discharging sinus persisted. At the time of her first operation she was coughing up enormous quantities of pus.

She entered Mt. Sinai Hospital on April 19, 1913. The left lung was entirely dull and in its lower third flat. There were bronchial breathing and numerous râles.

There was a deep sinus in the posterior axillary line at the level of the eighth rib and when the patient coughed there was a mucopurulent discharge.

X-ray by Dr. Jaches showed in the left chest one homogeneous shadow, denser below.

On May 26, 1913, in ether intratracheal anaesthesia, I made long resections of the sixth and seventh ribs in the postaxillary region but extending far toward the back. A honeycomb cavity fully as large as a man's fist was exposed, the walls lined with sluggish granulations and showing five separate bronchial fistulae of various sizes. The tough pleura on the costal side was resected and the huge cavity was packed (see Fig. 6).

The patient made rapid improvement and the wound again shrank to a sinus, which was in truth a mere bronchial fistula discharging opalescent mucus when the patient coughed. She was discharged three months after the operation.

Twelve weeks later, November 15, 1913, there was an infection of the sinus with constitutional symptoms. Under suitable dressings the bronchial fistula regained its "normal" condition.

Critical Note.—This case illustrates the futility of expecting a radical cure of these bronchiectatic cavities by ordinary drainage, no matter how perfect. The walls are rigid and the bronchial openings cannot fall together nor do they granulate. I repeatedly tested the various escharotics and the actual cautery through the ample opening, but with no good effect. In another case—perhaps even later in this one—an attempt might be made to dissect out a stump of each bronchus from the wall of the cavity, crush it and ligate in the hope that granulation tissue might then form and lead to a permanent closure.

CASE VI.—*Diffuse pulmonary gangrene; hæmopneumothorax; thoracotomy. Death.* H. A., a man of forty-eight and previously healthy, was seen by me in consultation with Dr. D. H. Davison on October 11, 1913, after two weeks of what had been diagnosed left septic pneumonia. The disease showed no tendency to clear up and the entire left chest was flat to percussion. Aspiration by the attending physician withdrew foul, sanguineous fluid which under the microscope showed no white cells but granular detritus, bacteria and blood pigment with broken down blood-cells. The heart was but little displaced. Patient icteric and septic with pulse 120 and temperature 104°. There was little cough and no foul odor from the mouth.

A few hours later, in local anaesthesia, I resected the eighth rib in the posterior axillary line, evacuating much fluid, clot and fetid gas.

Next day I was able to get a good view of the lung itself which was dry and obviously gangrenous as far as the eye could see. The pleura also was sloughing and a whistling sound within the chest indicated an opening into the lung. The wound remained dry and necrotic, delirium supervened and four days after operation death occurred. No postmortem.

Note.—This case is of interest principally because of the absence of physical signs indicating pneumothorax. The entire chest in all postures was absolutely flat to percussion, yet there was much gas under pressure in the pleural cavity. The character of the aspirated fluid and especially the absence of pus cells led us to diagnose perforation of the lung before operation. I have seen the same noncellular foul sanguinolent fluid in a chest some days after a gunshot injury of the lung. Judging by the great extent of the lung necrosis this case was hopeless from the first.

It was one of those cases, rare on the operating table, in which there was gangrene without suppuration.

CASE VII.—*Acute abscess of the lung; thoracotomy and drainage.* About seven months before admission to Mt. Sinai Hospital, Harry L., forty-one years old, had been seized with a malady accompanied by a severe cough with fetid expectoration, following undue exposure to cold. There was fever and loss of weight. The amount of expectoration was as much as eight ounces in a day. There had been no night sweats.

He was transferred from the medical service of Dr. Alfred Meyer on March 29, 1912, after a residence of several weeks in the hospital. During this time his temperature had rarely risen to more than 100°. Repeated examination of the sputum had failed to disclose tubercle bacilli but there were distinct evidences of pulmonary disease of the upper portion of the left chest.

An X-ray examination on February 7 showed a distinct circular shadow below the left pulmonic apex and apparently nearer the back of the chest than the front (Fig. 7).

About the 22nd or 23rd of March the patient began to have high fever with alternating drops of temperature, but the sputum was still negative for tubercle bacilli and the white blood count was normal. On March 29 Dr. Meyer had aspirated pus through the anterior part of the chest.

The same afternoon under ether administered by the intratracheal insufflation method, I made an incision beginning near the apex of the axilla and running parallel to the border of the latissimus dorsi muscle for about six inches. The serratus magnus was divided at this place. Sections of the third, fourth and fifth ribs were removed over an area the size of the palm of the hand. Careful dissection between mouse-tooth forceps showed that the pleura was intimately adherent to the lung. Aspiration of the abscess was followed by a free opening made with the dressing forceps, the general pleural cavity remaining uninvaded. On digital exploration there was thorough walling off, although from the large quantity of pus expectorated it was most probable that an opening into the bronchus existed. The abscess cavity was irrigated, then lined with a pouch of rubber dam which in turn was filled with gauze. Iodoformized gauze was packed into the external part of the wound and a few sutures were placed in its lower part. During the operation there had been a con-

siderable discharge of pus and mucus from the mouth. The patient was sent back to the ward in good condition.

Although during the next 48 hours the temperature came down, the patient was in a very uncomfortable and serious condition, owing to the gathering of large quantities of discharge in his trachea. This he seemed unable to expectorate, although on observation it appeared that he raised and swallowed the discharge. Periodically the foot of the patient's bed was elevated eighteen inches and he was turned upon his face in the hope that this might facilitate the bringing up of the pus.

Four days after the operation the patient died, evidently of a pneumonic process, probably near the site of the abscess. No autopsy was permitted.

Critical Note.—Apparently a serious secondary infection with putrid abscess had begun when the temperature rose just before the operation. The patient's condition then seemed grave.

One technical error was committed—namely, the irrigation of the abscess cavity. It has been pointed out by Garré and Quincke that this procedure is particularly hazardous because of the danger that septic fluids may enter bronchi which until then have escaped or that the infection may even run over into the healthy lung. And it appears to me that even with the advantage of intratracheal anaesthesia fluid introduced in great quantity, as by irrigation, may not be blown out of the mouth quickly enough to prevent extensive septic flooding.

CASE VIII.—Acute abscess of the lung; thoracotomy and drainage. Miss E. B., twenty-four years old, had been well until September 24, 1912, when she had an attack of what was called "la grippe." The most annoying symptom was pain in the external anterior part of the right chest at about the level of the third or fourth rib, and this point was also very tender to the touch. For four weeks the patient ran an irregular temperature, the pain and tenderness persisting.

I saw her with her physician, Dr. Manges, on October 12, in the Private Pavilion of Mt. Sinai Hospital. Aspiration had been performed a few days before when a little slightly clouded serum had been withdrawn. Subsequent aspiration was, however, negative. A Röntgen picture suggested fluid to the level of the seventh or eighth rib in the right chest (Fig. 8). The patient's condition

was wretched. There was mucopurulent, blood-tinged expectoration, cyanosis and dyspnea.

In nitrous oxide and oxygen anæsthesia, I aspirated repeatedly in the posterior axillary region but with negative result. I then made an incision parallel to the border of the latissimus dorsi muscle and removed generous sections of the eighth and ninth ribs, opening the pleural cavity for inspection. There was no fluid and there was but one firm, dense adhesion binding the lower lobe anteriorly to the chest wall. Otherwise, although the right lung appeared to be covered with a rather thin layer of greyish membrane, there were no adhesions.

The peculiar greyish appearance of the diaphragm was so remarkable that I excised a minute piece of it under the impression that its examination might prove useful. The muscle was, however, so extremely thin that the tiny opening spread until it was fully as large as a dime. I closed this by a single mattress suture. The chest wound was now also closed, a piece of gauze being left as a packing down to the adhesion. At the end of the operation it was found that the patient had had a considerable discharge of blood from the mouth.

There was a decided improvement in the general condition following this merely exploratory procedure and the wound healed kindly without the occurrence of intrapleural suppuration. The pain in the anterior chest, however, did not disappear and cough and expectoration continued. The temperature rarely rose now to a point beyond 101° . There was considerable improvement in nutrition.

About the tenth of November a point of induration was noted just beneath the right mamma, and four days later, in nitrous oxide anæsthesia, a long incision was made in the inframammary fold and pus was encountered here outside of the chest itself. The mamma was turned up off the chest wall and the origin of the flow of pus was found in the nipple line just below the fifth rib. A section of this bone was removed and the finger could easily explore a sponge-like abscess about 30 c.c. in extent. A tube was put in as a drain and the submammary exposed space was lightly packed with gauze.

Convalescence from the operation was rapid and the patient was discharged from the hospital in a month. A few weeks

later healing was complete. The inframammary cicatrix was most unobtrusive.

Note.—In the case just reported the exact diagnosis was in doubt. Referring to the radiograph (Fig. 8.), the straight horizontal limit of the right chest shadow strongly suggested fluid level—yet this appearance must have been caused by something else unless we can imagine that an extremely thin layer of liquid exudate could have caused it. Comparing the density of media in the two "clear" parts of the chest there is no hint of compression on the right side such as we might have expected had fluid forced the lung upward.

My first operation was truly an exploration and it accomplished the localization of the abscess and gave knowledge as to the extent of the adhesions, so that at the second step I resected rib without fear of invading the uninfected part of the pleural cavity. I have since made use of this double operation with success.

CASE IX.—Abscess of the lung complicating paratyphoid fever; thoracotomy and drainage. On December 22, 1912, N. S., a man of twenty-two, was transferred from the Rockefeller Hospital to Mt. Sinai Hospital with a diagnosis of empyema in the course of paratyphoid fever.

The history abstract stated that he had also been treated at the Rockefeller Hospital for what appeared to be a complicating lobar pneumonia. He had been aspirated in the seventh interspace at the right scapular line and 20 c.c. of thick, greenish pus had been obtained.

On examination there was dulness below the fourth rib anteriorly and beneath the level of the eighth dorsal spine posteriorly. Breath sounds over the flat area were diminished or absent. Fremitus was increased.

The white blood-cells were but 10,200, the temperature was 101°, the pulse 100 and the respiration 24.

The patient still suffered from his paratyphoid infection and was acutely ill.

On the following day he was anaesthetized with nitrous oxide and oxygen and I resected the seventh rib where it crossed the border of the latissimus dorsi muscle. Before making the incision aspiration was practised and only on very deep puncture toward the base of the chest was pus obtained. Entering the chest after the rib resection there was no fluid and there were no

adhesions, except of the right lower pulmonary lobe to the diaphragm and outer chest wall. Under the guidance of the eye an indurated place in the right lower lobe was aspirated and pus obtained. It was then determined not to evacuate the abscess at this sitting. Instead, a portion of the eighth rib was also excised so as to make the opening into the chest ample. Gauze packings were put in so as to cause the formation of adhesions between the parietal and visceral pleuræ above the abscess, with a view to evacuation at a second sitting.

Four days later the patient was again taken to the operating room and without anaesthesia the central packing, which went down to the abscess, was removed, leaving the "walling off" packing undisturbed. The opening was large enough to permit of aspiration with the aid of sight through the very thick firm-walled abscess and pus was again obtained. The scalpel was now carried down to the point where the needle entered the lung and the abscess wall, tough and almost cartilaginous in feel, was incised and the opening enlarged with dressing forceps, but the fluid was evidently not under very great tension and it was not until the patient was turned upon his side that a large quantity of extremely foul and thick pus poured out in a syrupy stream. A large sized drainage tube was carried several inches into the cavity which was irrigated and new packings were placed around that part of the tube between the thoracic wall and the actual opening of the abscess.

The culture from the laboratory was reported "streptococcus" (examined by Dr. P. Aschner).

On January 8, 1913, twelve days after the evacuation of the abscess, the last of the walling-off packing was removed, much force being required to detach it from the pleural adhesions. Now local improvement set in but the constitutional symptoms were still severe, the temperature often reaching 105°. The wound was apparently divided into two parts, the first being virtually an encapsulated empyema, the actual lung abscess being entered by an opening just about large enough to fit the tube and this opening was almost a finger's length from the surface. On account of the very great rigidity of the abscess walls drainage was not easy. The patient was now transferred to a bed on the roof and a suction apparatus was improvised with the aid of a vacuum cleaner and a bottle for collecting the discharge. This

was kept going day and night and I believe contributed greatly to the comfort of the patient and to his convalescence. The wound was healed in the latter part of April and the patient was sent to a convalescent home in the country. He gained rapidly in health and strength, although his cough was slow in disappearing. In June the cicatrix broke down and discharged for a few weeks but closed spontaneously and the man has remained in excellent health ever since.

Note.—In spite of the history of pneumonia and the careful examinations made by the Staff of the Rockefeller Hospital, it appears to have been impossible to make an accurate pre-operative diagnosis in this complicated case. The suspected empyema turned out to be a lower lobe abscess and though there was no sign of subphrenic suppuration before operation it may well be that an infection of this kind existed with slow boring of pus into the chest and into the adherent lung on its way toward a bronchus whence, had the patient's strength held out, evacuation through the mouth might have resulted.

Drainage by the use of the vacuum cleaner surely benefited this man—and for some days the same device with two tubes sufficed to empty the abscess of H. G. (Case IV), the one machine doing double duty. I now make use of a special suction pump devised by an instrument maker. This apparatus consists of an electric pump, a vacuum tank and a gauge for regulating the suction power. The pump acts intermittently, ceasing when the required vacuum in the tank has been secured and starting automatically when necessary to keep up the requisite exhaustion of air. The machine is quiet and requires but little attention.

A case of interest in comparison with that of N. S. is here recorded.

CASE X.—A. M., thirty-five years old, a physician, was referred to me by Dr. James A. Miller, on January 8, 1913.

One year before he had been operated upon for chronic appendicitis. There had been primary union but at the end of a week he had what was called "paralysis of the bowels." He was up and about six weeks after the operation but he walked with his body bent to the right. Suddenly he coughed up a large amount of pus. Ever since then he had had attacks of coughing and raising mucopus sometimes with blood, the whole never amounting to more than four ounces in a day. Occasionally a whole

month would pass without cough. When the abscess filled he had fever.

A radiograph made by Dr. Lewis Gregory Cole is here reproduced (Fig. 10). Quoting in part from Dr. Cole's report, "There is a thickening around both roots and one of the branches of the right descending bronchi. There is consolidation of the lower part of the right lung obliterating the costodiaphragmatic angle, or the lung may be displaced upward by an accumulation of fluid in this region. The thickening along the branch of the right descending bronchus indicates that this is the route by which this abscess cavity empties. The thickening around the root on the opposite side indicates that there is a slight infection in this region. There is no evidence of any other abscess in the parenchyma of the lung."

Considering the patient's condition, which was not bad, and the fact that he would go sometimes as long as a month without a discharge from the abscess and without fever, I suggested that a culture should be made from the sputum with a view to auto-gogenous vaccine therapy. A pure streptococcus strain was found at the Sondern Laboratory in June and fifteen injections were taken. On October 21 the patient presented himself looking well. He stated that there had been but one slight attack in four months.

I believe that the prognosis in this case is favorable for a final complete obliteration and cicatrization of this suppurating cavity.

CASE XI.—Abscess of left lung, upper lobe; thoracotomy and drainage. The unusual case of V. H., a boy of twelve, is interesting. He had been for some weeks under the observation of Dr. Koplik and had entered Mt. Sinai Hospital late in December, 1912. The history was one of left pneumonia in infancy; tonsils and adenoids removed in 1910. A few months prior to admission he had had a pneumonia and this was followed by chronic cough and an occasional haemoptysis, with pain in the left chest.

The boy looked pale and thin. There was clubbing of the fingers. Physical examination of the lungs showed, posteriorly, dulness at the left apex to a finger's breadth below the spine of the scapula. Anteriorly and in the upper axilla there was dulness.

The dull areas showed bronchial voice and breathing with sub-

crepitant râles over the left supraspinous region. Broncho-vesicular breathing over the left interscapular region.

The blood count: white cells, 15,000; polynuclears, 54 per cent.; small lymphocytes, 27 per cent.; large lymphocytes, 16 per cent.; transitionals, 1 per cent.; eosinophiles, 2 per cent.

Neither the sputum nor the Von Pirquet test gave evidence of tuberculosis.

On December 21, 1912, pus was obtained by aspirating in the left armpit, the needle pointing upward and backward.

Operation.—On January 2, 1913, in ether anaesthesia, an incision was made from the middle of the clavicle downward two and a half inches, dividing some of the pectoralis fibres. About three-quarters of an inch of the second rib was resected, the aspirating needle forced through the thick, almost cartilaginous, tissues and the abscess opened widely with director and dressing forceps. About three drachms of thick, foul pus were evacuated and tube drainage instituted.

Below and to the outer side of the abscess walls normal pleura could be seen moving with respiration.

For two weeks the case went smoothly and the patient improved, the cough diminishing. Then came fever and pain in the wound. Aspiration and digital examination failing to disclose the cause of the continued fever, cough and slight haemoptysis, the patient, on January 24, 1913, was once more anaesthetized and, guided by a finger in the wound, a needle was passed through the posterior wall of the cavity where a few drops of thick foul pus were obtained. A dressing forceps following the needle was pushed through until its blades could be felt beneath the skin just above the scapula and here a second incision was made. A large drainage tube was drawn directly through the apex of the lung, from back to front. Improvement went on from this time, though progress was interrupted by occasional fever. Fifteen days after the last operation the tube was replaced by three strands of thick silk. Ten days later the silk was withdrawn and the tract filled with Mosetig-Moorhof's iodoformized wax. About three months after the first operation the boy was discharged recovered. He has continued in excellent general health, does not cough and has become big and strong. He has even "grown up to" his clubbed fingers, the deformity having almost disappeared (see Fig. 11).

Critical Note.—Surgically speaking, this was a case of lung abscess. Dr. Koplik regarded it as one of apical empyema, but whether or not the case began in the pleura the suppuration was anatomically in the lung, as shown by operation and by the expectoration of pus and by the haemoptyses. I do not regard it as primarily bronchiectatic but as an abscess caused by pulmonary necrosis in the course of a pneumonia, bronchiectasis perhaps occurring secondarily. The extremely dense, tough wall about the pus sacs—at least two in number—is suggestive of "indurative bronchiectasis."

CASE XII.—Fetid bronchitis mistaken for chronic abscess of the lung; extrapleural tamponade with paraffin (Tuffier). The patient, J. P., was a man forty-two years old. His disease began with cough, slight fever, profuse mucopurulent expectoration and night sweats with loss of weight. Sometimes he vomited after a severe coughing spell. There developed pain in the right chest and the odor of the sputum became foul. The temperature gradually rose until it reached 104° with the pulse rate varying between 96 and 120. Two weeks after the onset he entered Mt. Sinai Hospital on the medical side. This was on August 8, 1913.

The physical examination of the lungs at that time showed dulness with diminished breathing in the right axilla. Posteriorly, on the right side there was dulness from a point two fingers breadth above the angle of the scapula down to the base, with diminished vesicular breathing and diminished fremitus accompanied by noisy crepitant and subcrepitant râles.

The blood count showed 18,800 white blood-cells with 75 per cent. polymorphonuclears, 24 per cent. lymphocytes and 1 per cent. eosinophiles.

The sputum was very abundant, pale yellowish-green and persistently negative for tubercle bacilli.

On August 15, 1913, and again on the 29th an X-ray examination was made by Dr. Jaches. The report stated that the right apex showed slight density with infiltration of the root of the lung and with bronchial nodes. At the right base there was a dense infiltration continuous with that of the right lung. The right diaphragm was high (Fig. 12).

The findings on fluoroscopy indicated the presence of fluid in the right costophrenic space. The diaphragm on that side was fixed.

The patient was kept under observation for a number of weeks, occupying a bed in the open air on the roof and in excellent hygienic surroundings. There was, however, no improvement—rather a retrogression, although the general condition remained good.

There appeared to be two kinds of sputum; the one not foul, the other extremely fetid. The amount gradually increased until on November 6, 750 c.c. in twenty-four hours were discharged.

Early in November, the patient was examined by Professor Tuffier of Paris, and his case was pronounced a suitable one for the operation of extrapleural compression.

Some days later bronchoscopy was performed in local anaesthesia by Dr. Yankauer. At this time there was no sign of bronchial dilatation nor was there at the time of the bronchoscopy any discharge of foul pus. Dr. Yankauer, therefore, concluded that probably there was a parenchymatous lung abscess communicating with a bronchus, and he believed that at the time of the examination this communication must have been plugged.

On November 7, 1913, in ether anaesthesia administered by the intratracheal method, I made an intercostal incision between the eighth and the ninth ribs through the endothoracic fascia to the pleura, which was then separated digitally from the chest wall without opening the sac itself. This peeling away of the pleura was done as Tuffier advises—very slowly and carefully. It was not a difficult procedure. The ribs of this patient, however, were very close together and I wished to avoid the long intercostal incision. In order to gain more space I resected about four inches of the eighth rib. There was finally a cavity formed which I judged to be about 400 c.c. in size. During this procedure there was a discharge of extremely foul pus from the patient's mouth.

Paraffin, with a melting point between 105 and 108° F., was then put in—about 300 c.c. in all. I began with the paraffin in the liquid state but this was unmanageable, since it did not solidify quickly enough to prevent its being expelled and, therefore, pieces of soft solid paraffin were eventually employed. The patient stood this operation well although his pulse rose to 105°. The wound was closed without drainage.

The immediate result of the operation appeared to be favorable. The patient expectorated much less than before, but on

November 10, on examining the wound there was much bulging and on separating the edges a large quantity of turbid serum escaped. The patient then gradually deteriorated and the septic manifestations became progressively worse.

On November 19 I was obliged to reopen the entire wound without anæsthesia and I removed the paraffin, packing the cavity lightly with gauze. Two days later, also without anæsthesia, I aspirated the lung hoping to find the abscess but without success. Death from his septic chest condition occurred on November 28.

An autopsy through the wound was performed by Dr. Baehr and this brought forth some interesting and suggestive disclosures.

At the site of the operation and, in fact, over the entire right base the visceral and parietal pleuræ were densely adherent. There was found not a single large collection of pus in the lung but in each lower lobe there were eight or nine small abscesses, most of them from one to two centimetres in diameter and lined by pyogenic membrane. The bronchi to both lower lobes and some to the upper showed intense congestion of the mucous membrane and in some places hemorrhage. All the bronchi were filled with thick, greyish-white purulent material. In addition to the abscesses there were some small areas of grey hepatization and small areas of gangrene, particularly in the right lower lobe. The latter as well as many of the abscesses were peribronchial in distribution. In the left lower lobe there were numerous small areas of purulent bronchopneumonia.

I will now quote from the microscopical examination:

"There is a marked thickening of the pleura from which fibrous bands run into the lungs. The walls of some of the bronchi are infiltrated with polynuclear and round-cells. Many of the small abscesses can be definitely seen to have their origin in and about a small bronchus. In addition to the presence of small purulent foci some of the portions of the lung are seen to be completely necrotic."

The bacteriology showed the presence of diplococci, probably pneumococci, some streptococci and an abundance of Gram-positive and Gram-negative bacilli.

All the time that we thought we were dealing with a bronchiectatic abscess or some other form of lung abscess the disease was in reality a presumably incurable septic fetid bronchitis with its sequelæ of suppuration and necrosis in the lung itself. And this particular error is one which has often been made. (Garré and Quincke.)

The case just reported was one in which there was a complete agreement in the diagnosis among all those who saw the patient clinically. He was supposed to be suffering from "bronchiectatic abscess of the right lower lobe." Yet the bronchoscopy changed all this, for no bronchiectasis was discovered. The case then, in view of the two kinds of sputum, began to look like one of extrabronchial abscess and, indeed, the post-mortem findings showed this in measure to be true, though there was no actual fistulous connection between one large abscess and a bronchus. The infection of the operative field is also hardly to be wondered at, remembering the close adhesion of the septic lung with the parietal pleura.

The misreading of the X-ray plates is an old story; and nowhere can one be misled more easily than in the diagnosis of intrathoracic conditions.

In a recent case which was in the service of a medical colleague signs pointed to a subdiaphragmatic abscess with lung fistula and the radiograph showed a high right midriff dome. The patient had expectorated eight ounces of foul pus in one gush. His condition was critical. Tenderness and a mass in the right upper abdominal quadrant led me to incise here and I quickly emptied a gangrenous gall-bladder. Still the X-ray would not permit the idea of subphrenic disease to be put aside. At a careful post-mortem examination there was no subphrenic abscess, no liver abscess, no lung abscess! I have, indeed, come to the conclusion that a high diaphragm often signifies a relaxation or paralysis of this muscle in nature's effort to reduce pressure upon inflamed organs, and that its existence is by no means pathognomonic of an exudate beneath.

CASE XIII.—Suppurative bronchiectasis; removal of right lower pulmonary lobe. Francis W., at two and three-fourths years of age, had fallen while he was holding some partially masticated nut in his mouth and, in the gasp which followed or accompanied his fall, some of the foreign material was aspirated into the lungs. There developed cough of a spasmodic nature, with the expectoration of much purulent mucus.

With the aid of the bronchoscope, Dr. Yankauer had succeeded in removing much of the foreign matter and was finally unable to discover anything more within the visible part of the lung. Bronchoscopy was performed six or seven times during the following year. Still the cough and expectoration continued and now fever and rapid pulse were also observed, the temperature reaching as high as 105° and fluctuating at this high level for several days at a time with remissions between.

An X-ray picture by Dr. Jaches showed opacity at the right base which extended up to the eighth rib (Fig. 13).

The child now entered the surgical department of Mt. Sinai Hospital. He was well nourished but pale and apathetic. There was very marked clubbing of the fingers and toes (Fig. 1). The usual signs of consolidation were found at the right base. The spasms of coughing with the ejection of large quantities of foul mucopus were most painful to watch.

Three times after admission to the Hospital he was bronchoscoped by Dr. Yankauer, and after each bronchoscopy with the clearing out of the cavity there was a remission in temperature. Judging by the amount of discharge at each emptying I had some hope that a Tuffier extrapleural tamponade might tend to improve the drainage in this case and, therefore, on January 23, 1914, in ether anæsthesia by the intrapharyngeal method managed by Dr. Branower, I made a long incision between the eighth and ninth ribs down to, but not through, the pleura. In order to get more room without making too long an incision I resected a part of the ninth rib and by digital separation I made a cavity about 40 c.c. in size. Into this I placed three pieces of fat from the abdominal wall of another patient and closed the wound without drainage. No improvement followed this procedure, the coughing spells and expectoration remaining about the same. For a few days the temperature remained in the neighborhood of 100° and then there was a sharp rise to 104° with corresponding constitutional symptoms. The wound was slightly infected and slow in healing.

A month later, February 27, 1914, a minute sinus remained. The child's condition, however, was such that something radical had to be done.

Another bronchoscopy by Dr. Yankauer enabled him to see

all the bronchial openings but the picture was practically unchanged. Dr. Branower again managing intrapharyngeal ether anaesthesia, I made a long incision above the eighth rib into the pleural cavity, spreading the ribs wide with retractors. The exposure was perfect. The two upper pulmonary lobes were apparently normal, of the usual yellowish-pink color of a child's lungs. The lower lobe, however, was liver color and of a firm consistency. The piece of implanted fat was in position and apparently alive. There were dense adhesions of the lower lobe to the diaphragm and to the lateral costal pleura. All adhesions were quickly and rather roughly freed with the finger so that it was possible to place a strong double ligature of chromicized catgut completely around the hilum of the lower lobe after having crushed the part with a powerful clamp. The lobe was then cut away. A slight oozing from the stump led me to transfix once more and to ligate again double. The stump was then carbolized, salt solution was placed within the thoracic cavity, a piece of gauze was laid against the raw surface of the stump and led out of the posterior angle of the wound and another little piece of gauze was placed in the original sinus. The ribs were then approximated with chromicized catgut by the pericostal method. A continuous suture of fine chromicized gut was used to hold the intercostal structures together and the cutaneous incision was sutured with fine silk. At the end of the operation the patient's pulse was about 150 but of good quality. The color which had been slightly cyanotic during the greater part of the operation became normal. Reaction was prompt and in less than an hour after the operation the boy was wide awake and crying. The hemorrhage had not been severe, most of it coming from the peeling away of the adhesions.

A careful examination of the lobe which had been removed showed that all the bronchi were dilated and turned into what might be called abscess cavities. There was no trace of a foreign body.

The first twenty-four hours after the operation the temperature did not rise higher than 101°. The patient's condition was good, pulse about 140, very little cough, no expectoration. Then there was a rise to 103° the pulse reaching the alarming rate of 200. The wound was at once dressed, a little superficial sup-

puration found and all skin sutures removed. The gauze at the posterior angle of the wound was loosened and there was a discharge of turbid fluid, probably a mixture of salt solution and pus. A tube was slipped in alongside the gauze and full stimulation was ordered. The haemoglobin a few days after operation was, to my surprise, 75 per cent. though the little patient looked very anaemic. Very gradually there was improvement, for two weeks, the child being in a serious condition, the pulse causing especial anxiety on account of its great rapidity.

About a week after the operation mechanical suction apparatus was fitted to the tube within the wound and this avoided frequent change of dressing. The patient's appetite remained good throughout.

On March 16, the slough representing the stump of the lung came away.

After this there was steady improvement and the patient, at the present writing, six weeks after the lung resection, is in a satisfactory state of convalescence. A very small opening in the chest is still present but the outlook is most favorable.¹

Note.—This case demonstrates that bronchiectasis originally caused by foreign body aspiration may persist in an apparently incurable state after the removal of the exciting cause.

The amount of fat put in at the time of the Tuffier's lipotamponade, in view of the later findings, was absurdly small. But judging by the appearance and size of the bronchiectasis as seen after the resection I doubt that enough fat could have been transplanted to cure the patient.

The cause of the tachycardia is somewhat obscure. Whether it was a septic phenomenon or whether, perhaps, it had to do with the changed pulmonary circulation it would be hard to say. Dr. Koplik, who saw the case in consultation, advised us to give digitalis and under this drug the pulse rate was certainly favorably influenced.

CASE XIV (Unfinished).—Bronchiectasis; thoracotomy and drainage. Louis G., thirty-three years old, was admitted to Mt. Sinai Hospital on February 26, 1914. He had been a patient of Dr. Mannheimer.

Four years before he had had pneumonia followed by empyema for which he had been operated upon. For three years

¹At the time of proof-reading, May 10, 1914, the boy is perfectly well.

he remained well then began to cough and expectorate large quantities of mucopurulent material. There were occasional marked haemoptyses. The daily amount of expectoration was eight ounces. The patient was altogether miserable and unable to work. He had lost weight and strength.

On admission, a cicatrix representing the former operation was seen in the posterior axillary line over the ninth rib which apparently had been resected. The general condition of the patient was good. The lungs anteriorly were negative and the right lung was also negative posteriorly. On the left there were signs representing consolidation from the left scapula to the base. There was clubbing of the fingers.

An X-ray picture showed an infiltration of the left base with what seemed to be a pulling of the cardiac apex to the left by adhesions.

About March 5 the patient was bronchoscoped by Dr. Yankauer. This bronchoscopy was rather unsatisfactory, owing to the extremely poor anaesthesia and the rigidity of the patient's neck which made it difficult to introduce the instrument. Dr. Yankauer failed to demonstrate a bronchiectasis but thought that he saw granulation tissue in the bronchial walls.

On March 11, 1914, in intratracheal ether anaesthesia, I incised one space above the old cicatrix and to my chagrin passed through the diaphragm and into the abdomen. The peritoneal opening was at once sutured and the chest entered in the seventh interspace with wide resection of the seventh and eighth ribs. There was a mass of pleuritic adhesions, the lung also being adherent to the chest wall so that twice it was injured and had to be sutured. A needle puncture now permitted the aspiration of a few drops of foul, thick pus and in the posterior part of the wound near the angle of the rib I opened into the now empty bronchiectatic sponge. The cavity, about 50 c.c. in bulk, was packed with gauze and part of the cutaneous wound closed with drainage. Considerable distress followed the operation, with cough, temperature 103° and bloody expectoration.

To-day, April 10, the patient's condition is improved and the wound is healing rapidly. He still expectorates from one to two ounces daily and his complete cure without further operation is doubtful.

HOWARD LILIENTHAL.

TABLE OF OPERATIVE CASES RECORDED.*

Case No.	Name.	Age.	Sex.	Date.	Disease.	Type of operation.	Anesthesia.	Immediate result.			Remarks.
								Post-operative days in hospital.	Cured.	Improved.	
1	B. F.	55	M	Feb. 21, 1910	Bronchiectasis	Exploration	Insufflation ether	27	...	1	...
2	I. B.	19	M	Aug. 17, 1911	Bronchiectasis	Thoracoplasty	Inhalation ether	42	...	1	Died one year later of pulmonary hemorrhage.
2	I. B.	20	M	Apr. 12, 1912	Bronchiectasis	Thoracoplasty	Inhalation ether	34	...	1	Infection of the other lung.
3	G. R.	30	M	Feb. 16, 1912	Bronchiectasis	Thoracoplasty	Inhalation ether	32	...	1	
4	H. G.	23	M	Dec. 20, 1912	Bronchiectasis	Thoracoplasty and drainage	Insufflation ether	60	...	1	Opening into bronchiectasis closed spontaneously.
4	H. G.	24	M	Nov. 21, 1913	Bronchiectasis	Large thoracoplasty (posterior)	Inhalation ether	90?	...	1	Improvement but condition still unsatisfactory, 3 to 4 ounces of sputum per day.
5	A. S.	26	F	May 26, 1913	Bronchiectasis with fistula	Free drainage by rib resection	Insufflation ether	90	...	1	
7	H. L.	41	M	Mar. 29, 1912	Acute abscess	Thoracoplasty and drainage	Insufflation ether	4	...	1	
8	E. B.	24	F	Oct. 12, 1912	Acute abscess	Exploratory thoracotomy	Gas and oxygen by inhalation				
8	E. B.	Nov. 14, 1912	Acute abscess	Second stage thoracotomy and drainage	Nitrous oxide inhalation	62	1	...	Patient remains well to date.
9	N. S.	22	M	Dec. 23, 1912	Acute abscess	Thoracotomy and drainage	Nitrous oxide	120	1	...	Patient well to date.
6	H. A.	48	M	Oct. 11, 1913	Pulmonary gangrene	Thoracotomy and drainage	Local	4	...	1	Hopeless from the beginning.
11	V. H.	12	M	Jan. 2, 1913	Chronic abscess of apex	Thoracotomy and drainage	Ether inhalation	88	1	...	Through drainage, supraspinous region to front of chest.
12	J. P.	42	M	Nov. 7, 1913	Fetid bronchitis	Extrapleural tamponade (Tuffier)	Insufflation ether	21	...	1	Case mistaken for bronchiectasis.

* CASE XIII, unfinished at time article was read, is now complete and adds one more cure. See history in body of text.

FIG. 1.



a.

Photograph and radiograph of hand of F. W., Case XIII. Cubbing of fingers with no visible change in the bones.



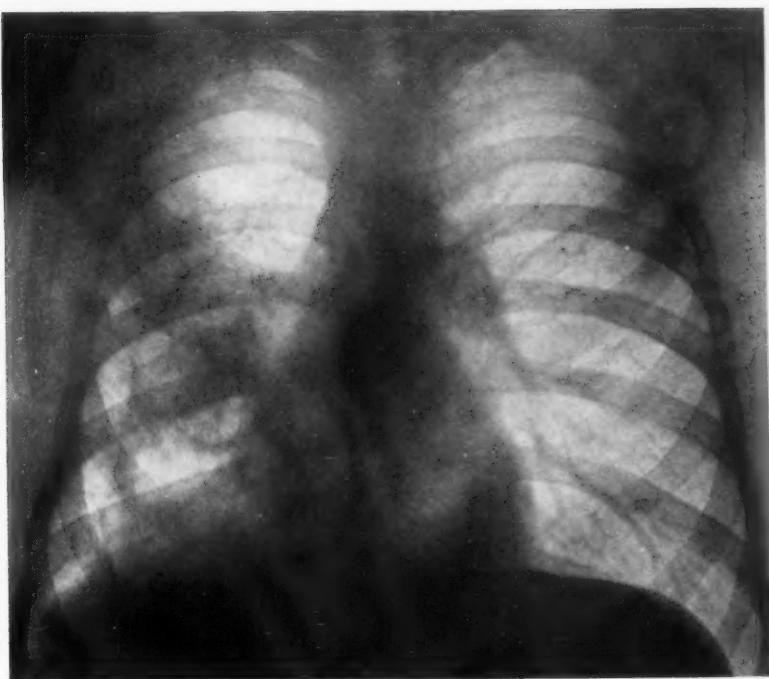
b.

FIG. 2.



Abscess partly filled with fluid. Note line of liquid level. Right upper lobe. (This patient was not operated upon.)

FIG. 3.



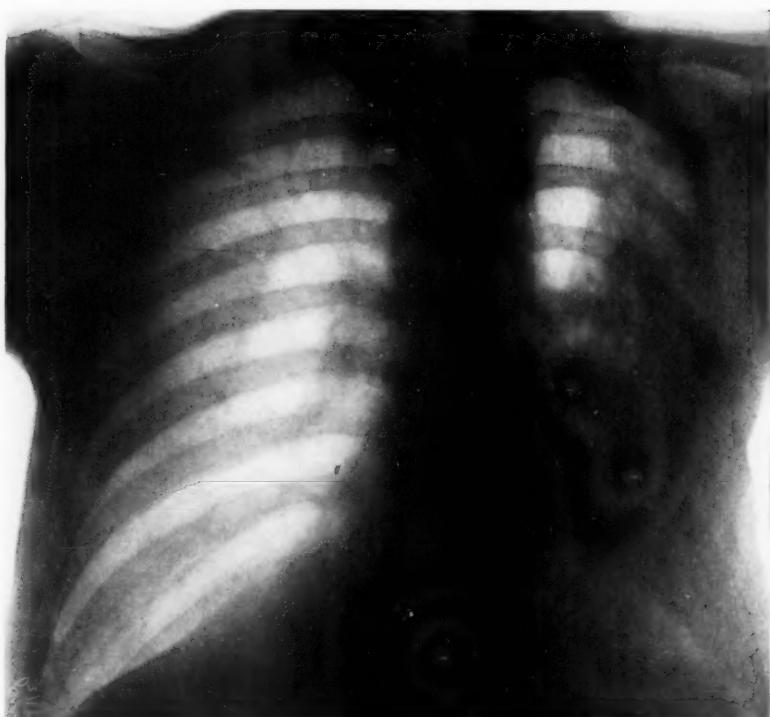
Anterior radiograph demonstrating extent of bronchiectatic mass. Compare with Fig. 5.

FIG. 4.



Case IV. Result of posterior thoracoplasty. Compare with Fig. 5.

FIG. 5.



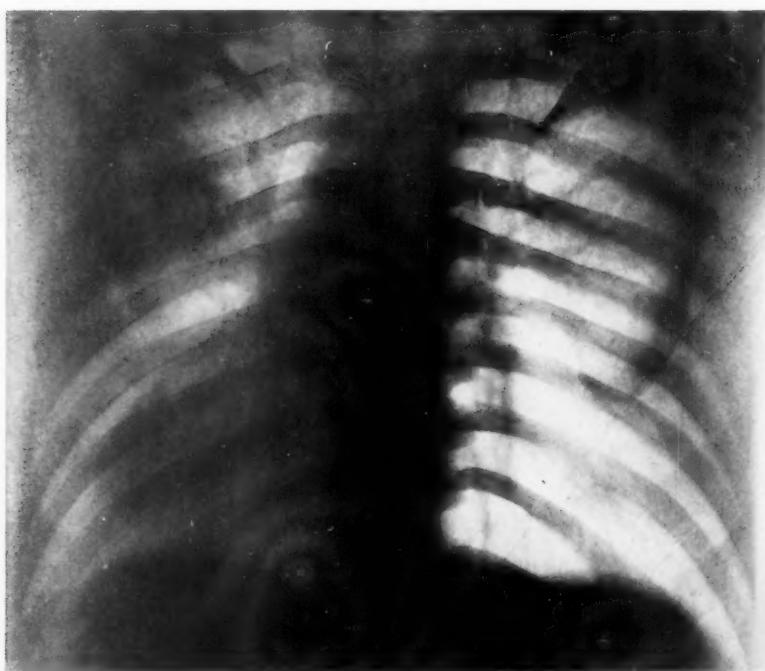
Posterior radiograph showing reduction in the capacity of the right chest following thoracoplasty. Case IV.

FIG. 6.



Drawing from sketch, Case V. Note the size of the wound and the five bronchial openings.
Even this thorough drainage did not result in cure.

FIG. 7.



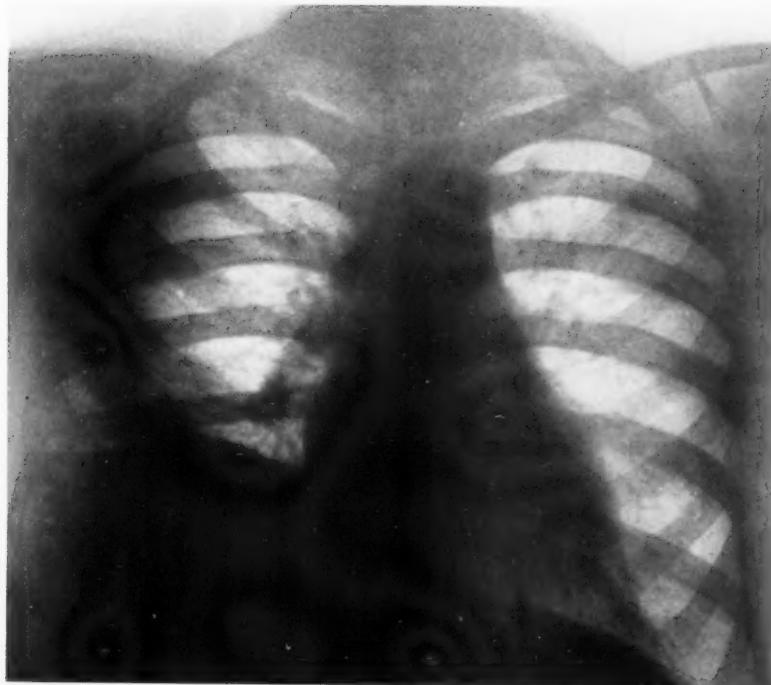
Posterior radiograph. Putrid abscess of left upper lobe. Case VII.

FIG. 8.



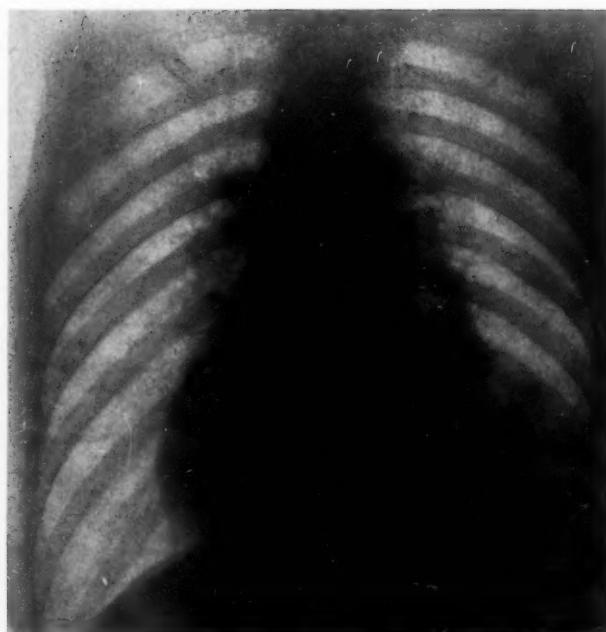
Acute lung abscess. Note pseudoliquid level. There was no free fluid in this chest. Case VIII. Miss E. B.

FIG. 9.



Case IX. Large putrid abscess right lower lobe. Probably from a subdiaphragmatic source.

FIG. 10.



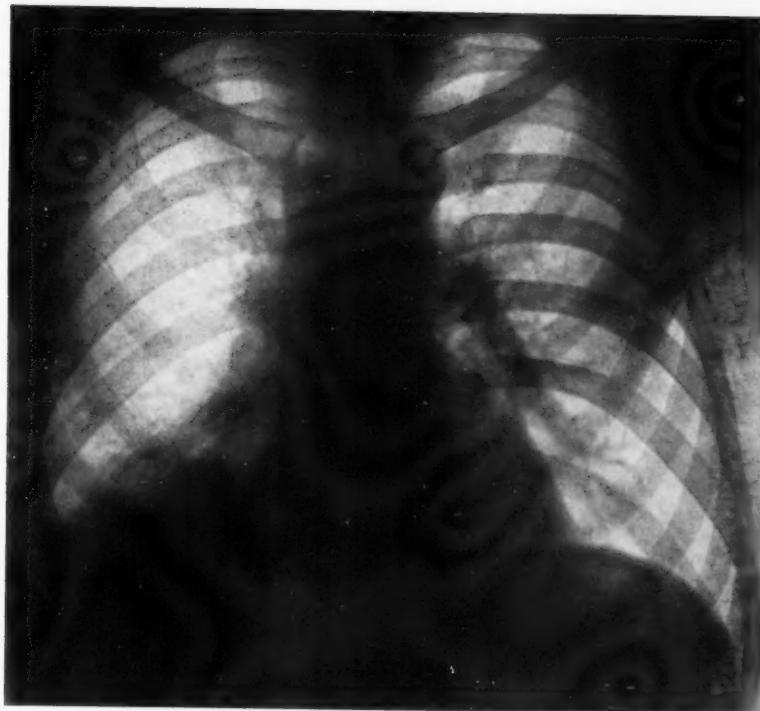
Case X. Showing opacity in right chest probably indicating course of subdiaphragmatic abscess to a bronchus.

FIG. 11.



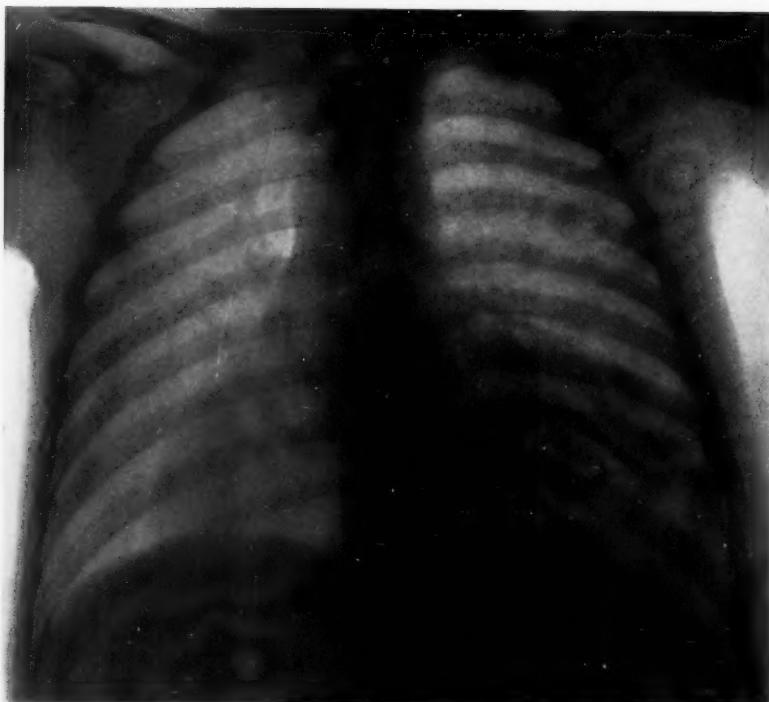
Photograph showing patient recovered after drainage of apical abscess. Clubbing of the fingers no longer present.

FIG. 12.



Case XII. Fetid bronchitis mistaken for right lower lobe bronchiectasis.

FIG. 13.



Case XIII. Case of bronchiectatic infection of entire right lower lobe.

CONCLUSIONS BASED ON OBSERVATIONS IN THE CASES
RECORDED.

1. The differential diagnosis of true lung abscess and suppurative bronchiectasis is important.
2. Radiographic study of each case is essential.
3. Bronchoscopic examination is a valuable procedure, and should not be omitted.
4. Drainage of a lung abscess by thoracotomy is likely to result in cure.
5. Drainage of large infected bronchiectases may be followed by improvement, but complete recovery is unlikely.
6. Extensive thoracoplasty should be reserved for those cases in which other operations have failed.
7. Exploration of the pleural cavity and of the lungs by intercostal thoracotomy is feasible and reasonably safe.
8. Extirpation of a bronchiectasis by removal of the affected portion of lung may lead to complete recovery. The danger of the operation is great.
9. Artificial pneumothorax and Tuffier's extrapleural tamponade should be reserved for cases of pure tuberculosis.
10. Intratracheal insufflation is a simple, accurate and safe method of securing differential pressure.
11. Operations involving one lung can be performed with inhalation anaesthesia.

VISCRAL PLEURECTOMY FOR CHRONIC
EMPYEMA.*

BY CHARLES H. MAYO, M.D.,

AND

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CHRONIC empyema is a condition which is quite common in spite of the fact that it results, in most instances, from the failure of early diagnosis and the establishment of sufficient drainage in the acute stage. In the acute stage, if free drainage is established early and the adhesions broken up at the time of the first drainage, the lung re-expands quickly, thus obliterating the abscessed cavity, and the patient goes on to rapid recovery. In the neglected case in which the infected fluid remains in the pleural cavity for a considerable length of time, the pleura becomes so thick and fibrous that even after free drainage is established, the lung cannot re-expand. In nearly all cases, this is because of the adhesions and the thickened pleura, and not due to any extensive disease of the lung. It is true that in some cases there is an abscess in the lung which drains spontaneously into the pleural cavity, but this does not seem to be the usual way in which an empyema takes place.

In the chronic cases of empyema the ribs prevent the chest wall from dropping in and the adhesions and the thickness of the pleura prevent the lung from re-expanding. The result is a large cavity which continues to discharge varying amounts of pus. Nature cannot obliterate this cavity, as she ordinarily obliterates cavities by collapse of the tissues about it. Neither can she force granulations through the fibrous wall of the abscess.

Various methods have been devised by surgeons to obliterate

* Read before the American Surgical Association, April 10, 1914.

ate this cavity. Estlander¹ resected the ribs subperiosteally over the entire area. The number of ribs resected varies with the size of the cavity. It is important to be radical and to resect one rib too many rather than one too few in order that no dead space remains in the upper or lower part of the cavity to continue suppuration. Many surgeons have modified this operation; for example, Sauboulttin,² Beck,³ Quenu,⁴ and Tietze⁵ resected small portions of the ribs through parallel and vertical incisions of the region involved. Jaboulay and Leymarie⁶ divided the sternal attachment of the ribs, making use of the articulation at the vertebral column to mobilize the chest-wall, while Boiffin⁷ recommends resection of the ribs close to the vertebral column, making use, as it were, of the mobility of the costal cartilages. More recently, Wilms⁸ has combined these two operations and resects a couple of inches of several ribs along the spine and also along the sternum in order to mobilize the chest-wall. Schede⁹ noticed that some empyema cavities did not heal even after extensive resections of ribs. He observed that the thickened pleurae did not unite with each other but directly impeded recovery. Consequently, he devised the operation which bears his name. This consists of removing not only the ribs covering the empyema cavity, but also the thickened parietal pleura and the intercostal muscles, so that the skin and superficial muscles rest directly against the thickened visceral pleura. This operation is usually performed through a U-shaped incision beginning along the external margin of the pectoralis major muscle to the lower part of the thorax and then backward and upward to the median line of the scapula. The skin, superficial muscles and scapula are then reflected upward, while the pleura, ribs and deeper muscles are removed over the entire cavity. The operation is severe and the shock to the patient is often alarming if not fatal, especially since many of these patients are in an extremely debilitated condition.

In 1893, Fowler,¹⁰ operating on a woman thirty-five years of age who had had an empyema with a fistula for ten years, dissected out the scar tissue surrounding the fistulous tract and removed the entire mass of

fibrous tissue from the diaphragm and lung. He was surprised to discover that the lung began to re-expand as soon as this thick scar tissue was peeled from it. The patient recovered from the operation and the wound entirely healed within a few weeks. The case was reported in December, 1893. In commenting on the case, Fowler stated that the history suggested a method of dealing with some of the cases of old empyema with a persistent sinus which resists all the means usually employed for their cure.

DeLorme,¹¹ after observing autopsy cases of old empyema, decided that the lung would re-expand if the thickened pleura was removed from it. Consequently he devised the same operation and reported it about three months later, in the early part of 1894. Unfortunately, his patient died from hemorrhage and shock.

These two men performed the same operation and arrived at the same conclusions concerning these cases, the difference being that one of them performed the operation, following out the steps as he proceeded, while the other studied out the operation in advance and then performed it. Ransohoff,¹² following the work of Fowler and DeLorme and appreciating the difficulty of removing the thickened pleura in some cases, advised making multiple incisions at right angles to each other about a quarter of an inch apart, through the thickened pleura down to the lung, so that the entire visceral pleura should be gridironed. This is a valuable procedure and may often be used with good results in conjunction with visceral pleurectomy.

We believe that the operations of Fowler and DeLorme have not received the attention from American surgeons which they deserve. We have been able to find but twenty-four cases reported in the literature by three operators in the twenty years that have elapsed since the reports of Fowler and DeLorme. The efforts of surgeons up to the time of their reports had evidently been directed entirely to obliterating the cavity in chronic empyema by collapsing the chest-wall. They apparently had not appreciated the fact that in most instances the lung itself was not badly diseased and that it would re-expand to a greater or less extent if given an opportunity. Even to-day the possibility of restoring a portion or even an entire lung to the patient is not fully appreciated. In this age of conserva-

tion it certainly seems worth while to attempt it even if we do not always succeed in restoring to the patient the use of a portion of such a valuable organ as the lung.

Keen's Surgery¹³ states that, as a rule, satisfactory results cannot be expected by this method if the operation is undertaken after four or five months have elapsed since the primary drainage. Von Bergmann's Surgery¹⁴ tells us to try decortication of the lung when other methods fail. If it is possible for the lung to re-expand in a reasonable proportion of the cases without involving more danger to the patient than by other methods, we accomplish everything that is accomplished by the other methods and, in addition, restore to the individual the use of a lung or portion of a lung. This factor certainly seems important enough to be considered seriously. In previous years the results from the Estlander and Schede operations were so discouraging that, through a process of evolution, we have gradually taken up the operation of visceral pleurectomy in conjunction with these other procedures.

We wish to report two cases in which this thickened pleura was removed from an entire lung in an adult, in both cases more than six months after a primary drainage.

CASE I (No. A31028).—Male, aged twenty years. Date of operation November, 1911. Patient had had typhoid fever. Sick for three months following the typhoid when an empyema was discovered on the right side and drained. This was in January, 1908. This had been draining at intervals until he first came under observation. Examination revealed a nearly collapsed lung on the right side, with an enormous cavity which extended from the diaphragm to the clavicle. Through an opening large enough to explore the cavity, the thick, fibrous pleura over the entire lung was removed. There were a number of fibrous bands which entered into the tissue or the lung and others that bound it to the diaphragm. These were freed as well as possible. The case was considered very unfavorable after the operation was finished. To our surprise, the lung soon filled the entire thoracic cavity and drainage was entirely stopped by January 5, 1912, fifty-one days after the operation. There were good breath-sounds over the

entire right thorax, the patient steadily gained in health and strength and has remained entirely well to the present time.

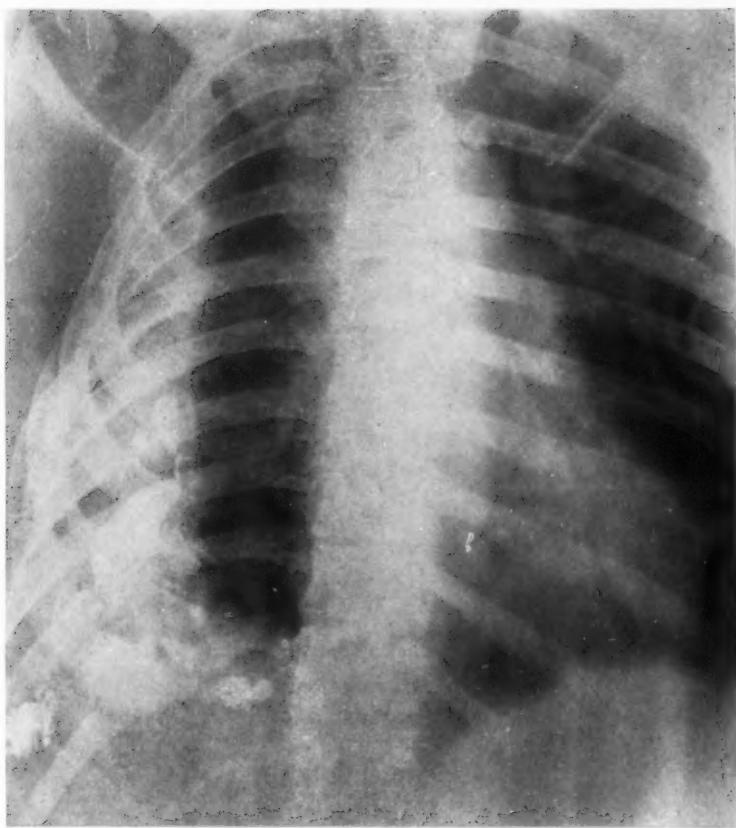
CASE II (No. A77103).—Male, aged twenty-three years. Examined December 7, 1912. Was shot with a rifle through the left chest in October, 1912. Bullet entered from in front, passed entirely through the thorax and was found lodged under the skin of the back. Three weeks later an empyema was drained. When examined the left thorax was shrunken, the patient very weak and emaciated and the entire left lung collapsed. He was advised to return to his physician to get in better condition to undergo a pleurectomy.

Six months following the primary drainage, in May, 1913, he returned for operation. A complete visceral pleurectomy of the left lung was made. The thickened pleura was removed from the lung, diaphragm and pericardium as well as possible. There was very little bleeding and, although the patient was emaciated and weak, there was almost no shock following operation. Drainage ceased entirely in three months. There were good breath-sounds over the entire thorax and he had gained nineteen pounds in weight. Two months later the patient returned with a small collection of pus in the pleural cavity under the left axilla. This was drained. He still has a small cavity at this point which will require further operation but at least two-thirds of the lung is functionating.

These two cases illustrate the possibility of a collapsed lung re-expanding even after many months. We do not intend to say that such results can be accomplished in every case of chronic empyema, and we realize that pleurectomy must be combined with resections of rib and the Ransohoff technic in most instances. We wish to emphasize the fact that in our experience pleurectomy has not produced anywhere near the same degree of shock that the Schede operation does. We believe that in most instances it should be attempted before extensive resections of rib are undertaken. If the lung only partially expands, resections can be done at a second operation without any loss except the time of the patient.

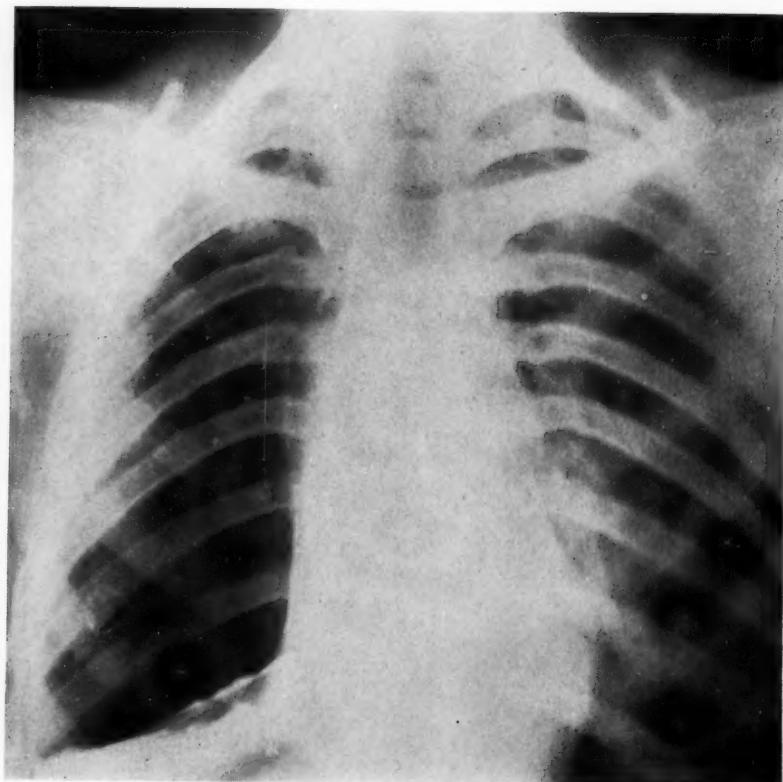
Tüffier¹⁵ recommends that with the patient in poor condition the operation be divided into several stages, rather than

FIG. 1.



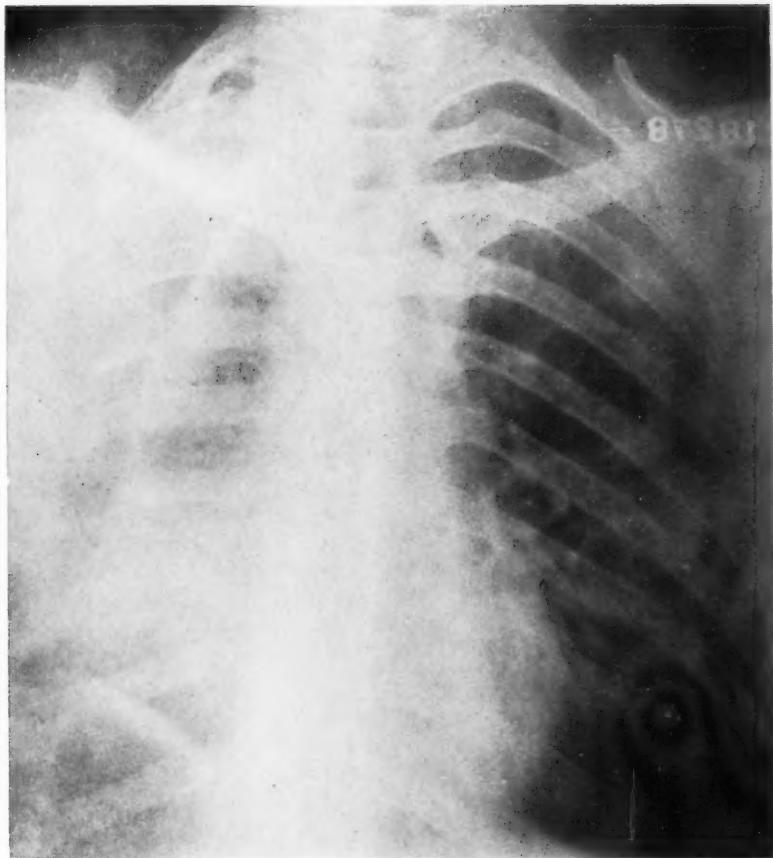
Before operation.

FIG. 2.



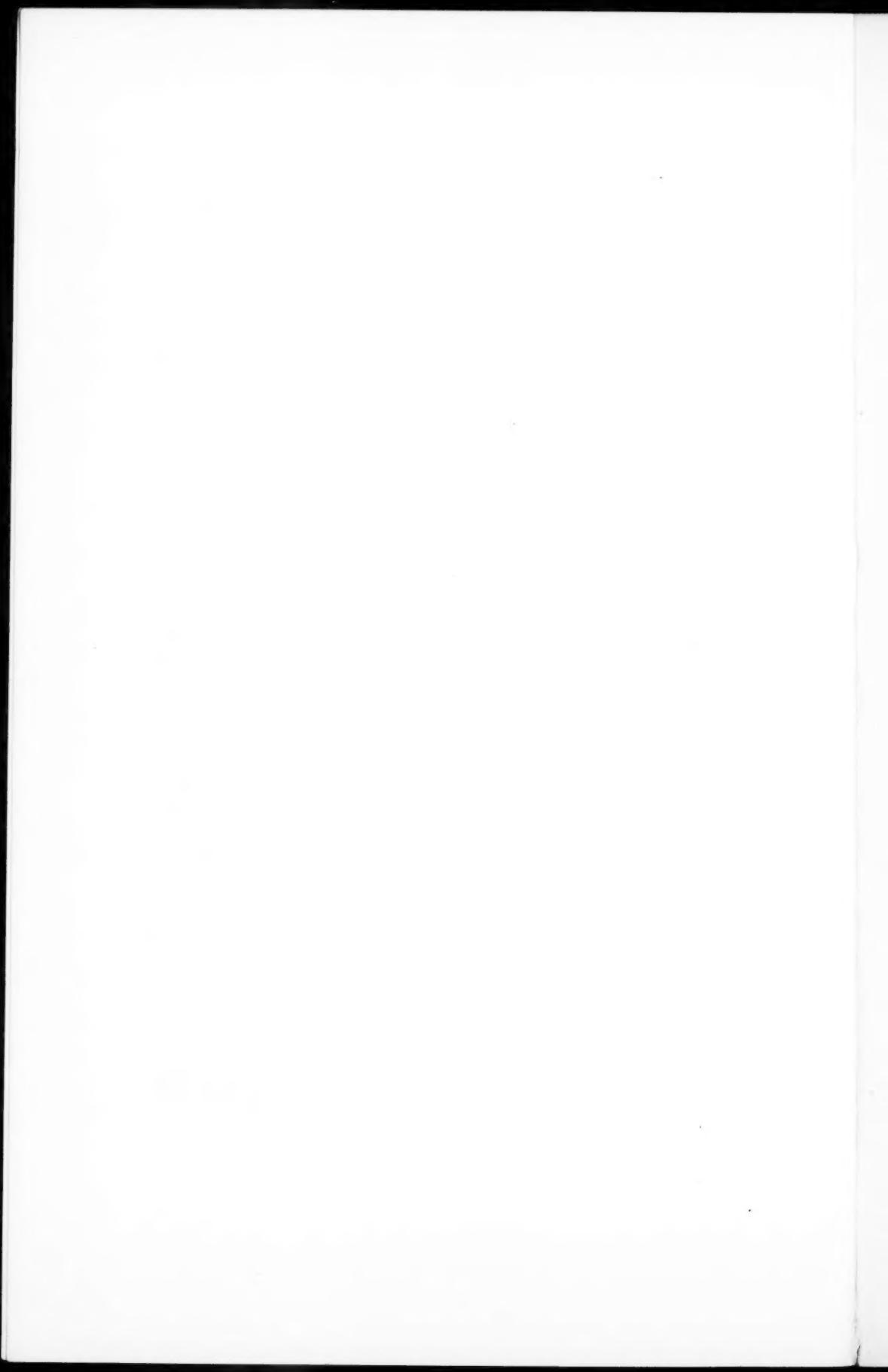
Before operation.

FIG. 2a.



Some weeks after operation, showing re-expansion of major part of the lung.

Worm



attempting to complete it in one stage. He also recommends the DeLorme operation in selected cases. We also believe that many of these cases should be operated upon in stages, and pleurectomy can be attempted. If this does not obliterate the entire cavity, one usually gains some lung expansion and the remainder of the cavity can be obliterated later by the Estlander or Schede operation.

We wish to report two other cases in which the wound healed primarily following pleurectomy.

CASE III (No. A71074).—Male, aged twenty-two years. Patient with a left sided empyema following pneumonia, which had drained at intervals for thirteen months. A cavity six inches in diameter posterior to the pericardium was explored and the thick membrane covering the pleura and diaphragm removed. The cavity healed entirely in thirty-nine days.

CASE IV (No. A73419).—Male, aged eighteen years. Patient had a left sided empyema which had drained for over two years. At operation, a cavity the size of a large grape-fruit was found external to the pericardium. The thick membrane was peeled from the lung and partly from the pericardium. The cavity closed in three weeks.

In discussing the treatment of such cases, a word should be said in regard to the preparation of the patients for operation. Many of these patients are as much in need of pre-operative preparatory treatment as patients about to undergo an operation for prostatectomy.

It is very important that the drainage should be at the most dependent part of the cavity. We have seen several patients gain from fifteen to twenty-five pounds in a few weeks with a corresponding gain in strength by changing the point of drainage to the most dependent part of the cavity. Autogenous vaccines should also be employed. After the patient has stopped gaining, following such an operation for drainage, and is in the best condition possible, irrigation of the cavity twice daily with a weak iodine solution helps reduce the infection to a minimum. In regard to the operation itself, sufficient

exposure must be obtained to make every portion of the cavity freely accessible. The entire cavity should be cleansed as thoroughly as possible and then swabbed with strong tincture of iodine before pleurectomy is begun. The incision through the thickened pleura is best started posteriorly along the vertebræ, as there is less danger, especially on the left side, of entering the pericardium. One need not fear slitting entirely through the thick pleura down to the healthy lung, as the bleeding does not seem to be excessive, and, although the lung has been injured enough to allow air bubbles to escape, in almost every instance no harm has arisen from such injury and apparently no extensive infection to the lung by such exposure has occurred. Pneumonia has not occurred in any of the seven cases in which pleurectomy has been performed. Abundant drainage to the furthest points of the cavity should be provided for by small gutta-percha drains to prevent re-accumulation of the fluid in the pleura. One operative death has occurred in this series. With our present knowledge we believe that too extensive an operation was attempted on this case. Now we divide the operation into stages when necessary.

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- ³ Beck: "Surgical Diseases of the Chest," 1907.
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THE PLEURAL AND PULMONARY COMPLICATIONS OF TROPICAL ABSCESS OF THE LIVER.

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A DESCRIPTION of the anatomic relations of the liver to the diaphragm and to the structures in contact with the upper surface of the diaphragm will make the study of the paths of direct extension of infection much easier to understand.

Most of the upper or convex surface of the liver is in contact with the diaphragm. Over the greater part of this area of contact the peritoneal cavity intervenes, potentially at least, each opposing structure being covered by its own layer of peritoneum. Over the rest of the area the liver and diaphragm are in actual structural contact, being separated by a layer of connective tissue only. *The area uncovered by peritoneum* is bounded in front by the attachments of the anterior layer of the right and left coronary ligaments and by their junction with the falciform ligament; behind by the posterior layer of the right and left coronary ligaments, and their reflection on to the posterior borders of the lobes of the liver and the anterior surface of the vena cava. Figure 1 representing the upper surface of a liver shows this area darkly shaded. The vena cava inferior grooves the liver at the middle of its posterior edge. It will be seen that at least four-fifths of this area lies in the right lobe of the liver. If a number of livers are examined in the dissecting room, it will be found in most cases that the highest point of the convex surface of the right lobe occupies a portion of the organ in front of this area, but that occasionally a liver is met with where the uncovered area represents the highest point and occupies the dome of the diaphragm. A study of the under surface of the diaphragm shows a replica of the upper surface of the liver.

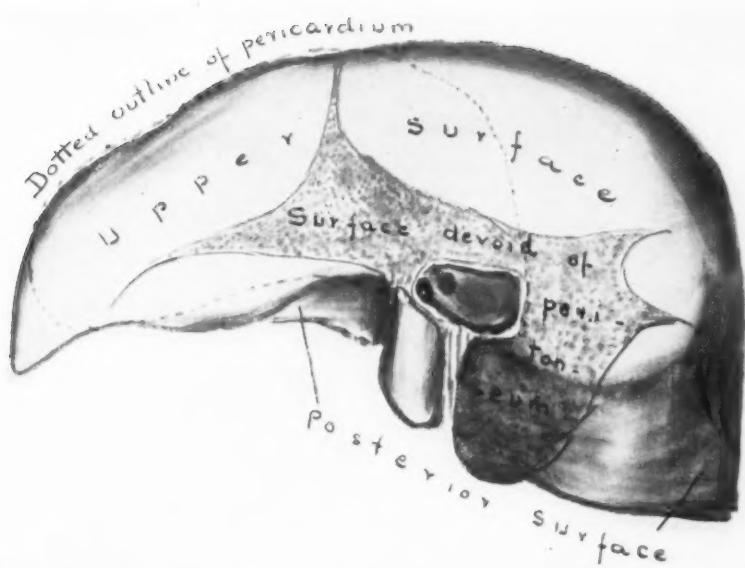
It has been stated by some writers that most liver abscesses that penetrate the diaphragm pierce it through this uncovered area. There is no doubt that it is a fairly frequent path of direct infection, but I have failed to find enough evidence to support

the statement. It seems to be an easy matter for an abscess in any part of the liver to contract adhesions to the under surface of the diaphragm and to pass upward through it. The frequency with which abscesses tend to point through the lower intercostal spaces in the axillary line, suggests at least that the peritoneum is no barrier. If an abscess occupies the upper portion of the right lobe of the liver, as it increases in size it will bulge toward the pleural cavity and the first effect will be to push the diaphragm against the chest wall, and obliterate the lower portion of the phrenicocostal sinus (Fig. 2). By doing so the lower edge of the lung is pushed upward, and is prevented from reaching the lower limit of this space even in forced inspiration. If the abscess extends in this direction, adhesion of the two layers of peritoneum and pleura occurs in advance and both peritoneal and pleural cavities are obliterated at these points. If, however, the abscess extends upward it may open into the pleural cavity above these adhesions, or directly into the lung if adhesions have formed between it and the upper surface of the diaphragm. The structures lying on the upper surface of the diaphragm, that correspond to the upper surface of the liver, are the whole base of the right lung, the base of the pericardium, and part of the base of the left lung. Fig. 1 explains this clearly. The area outlined in red represents the area of liver which is in relationship with the pericardium above. It is seen to occupy almost the whole of the upper surface of the left lobe and a considerable part of that of the right lobe, including almost half of the area uncovered by peritoneum. A very small area of the upper surface of the left lobe touches that part of the diaphragm in contact with the left lung. The right lobe of the liver touches the diaphragm over the whole area corresponding to the under surface of the right lung. Fig. 2 is a right lateral, sagittal section, and shows the reflection of peritoneum in front and behind, from the upper surface of the liver on to the diaphragm and posterior body wall. The phrenicocostal sinus is shown in front and behind.

Secondary extension of the inflammation from the liver to the lungs may occur in one of two ways.

1. By direct extension through the diaphragm.
2. By embolism of the pulmonary arteries due to the abscess bursting into the hepatic veins or into the vena cava.

FIG. 1.



Upper and posterior surfaces of liver. Shaded area uncovered by peritoneum. Dotted line outline of pericardium. Most of this pericardial area is occupied by central tendon.

I. DIRECT EXTENSION THROUGH THE DIAPHRAGM.

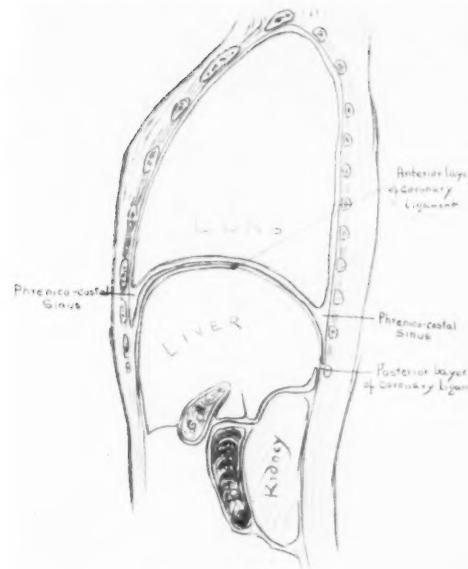
From the preceding anatomical description the paths of direct extension into the pleural cavity and to the lungs will be easily understood. The pleural cavity is probably never invaded by metastasis but always by direct extension, and the same path usually holds good for the lower lobes of the lungs. The process with a few modifications is as follows: Extension of the original liver abscess proceeds toward the diaphragmatic surface of the liver. The diaphragm is incorporated into the abscess cavity and is gradually destroyed. What occurs next will depend on a number of factors. If the necrotic process is rapid and no antecedent pleurisy has caused adhesion of the lower lobe of the lung to the diaphragm or to the chest wall, the pleural cavity will be opened and the contents of the abscess emptied into it suddenly, producing serious fulminating symptoms of dyspnoea and all the signs of an acute pleural effusion (Thomson). Usually the diaphragm is penetrated slowly and actual perforation is preceded by pleurisy, just as peritonitis precedes perforation of the abdominal viscera. The inflammation of the pleura may terminate in an accumulation of fluid, or in adhesions between the lung and the diaphragm or chest wall, or in both conditions to a different degree. In quite a large number of cases effusion is present in greater or lesser quantity. At first it is serous and sterile; later, it may become infected and seropurulent or purulent. At first the accumulation occupies the lower region of the chest cavity, the diaphragm forming its lower boundary. If no adhesions form between the lung and the chest wall the whole pleural cavity may become involved and filled with fluid. Owing to the frequency of adhesions between lung and parietal pleura, localized collections in the lower portion of the pleural cavity or even between the lung and diaphragm are more common.

When the diaphragm is perforated finally, the pus from the liver abscess mixes with the pleural fluid, imparting to it its own peculiar physical characteristics. The mingling of the two fluids is rarely attended by acute symptoms, because the pleural surfaces are now less susceptible to injury and the absorption of morbid products is less active. At the most,

there may be slight increase in pain or dyspnoea. The change of the fluid from serous to purulent may be discovered by chance even, at a subsequent tapping. When adhesions form between the diaphragm and the under surface of the lower lobe of the lung, the pleural cavity is shut off at an early date. As a rule, the application of the two surfaces is close and no cavity is left. But occasionally a small portion of the pleural cavity is imprisoned between the lower surface of the lung and the upper surface of the diaphragm. In the former case the inflammatory process passes slowly through the diaphragm into the lungs and the abscess cavity bores its way through the lung tissue until a bronchus is opened, into which the contents are finally discharged. In the latter the abscess opens first into the intervening cavity and later bores its way through the lungs.

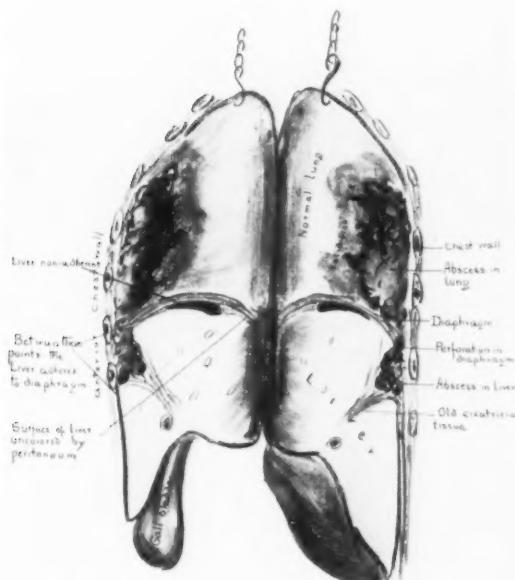
The post-mortem appearances of such conditions show marked anatomic variations. In some instances (usually recent cases) the hepatic abscess may still be of a reasonable size and the pulmonary track short and comparatively narrow. At a later date the track through the lung may be transformed into a large cavity which communicates with a similar cavity in the liver (Fig. 4). (Strong.) In others (older cases) the hepatic abscess may be reduced to a very small size, while the track in the lung may show extensive cavitation, of irregular shape and with ragged disintegrated walls. This disproportion between the cavities in the lung and liver is often so marked that the liver abscess may be considered as practically healed (Fig. 3). The cause of death in such cases must not be ascribed to the destruction of liver tissue, but to the pleural or pulmonary complications; or, in rare instances, to metastatic infection of other organs. In one of our cases (Case X) an abscess had opened primarily into the lower part of the pleural cavity, the lung being penetrated secondarily. The post-mortem examination showed that the liver abscess had almost healed up and that nearly all the pus which was being discharged through the bronchi had been formed in the pleural cavity and in a cavity found in the lungs. The lower lobe of the right lung

FIG. 2.



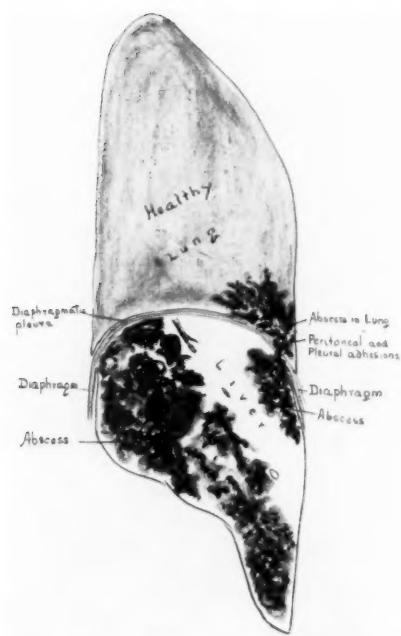
Right lateral sagittal section, 3 inches from medial plane.

FIG. 3.



Specimen of liver and lung laid open, showing abscess in liver almost healed but abscess in lung very large and active. (Path. Museum University of Texas.)

FIG. 4.



Sagittal section of lung and liver, showing multiple abscesses in the liver and a small abscess in the lung communicating with one in the liver. (Path. Museum University of Texas.)

was occupied by a cavity as large as a man's fist, the walls of which were disintegrated and friable. The contents consisted of pus of a chocolate color. The cavity drained externally into a large bronchus and opened by a small aperture into the pleural cavity. There was no direct connection between it and the liver. Careful examination of the upper surface of the diaphragm revealed a shallow excavation in its upper surface not more than one-half an inch deep and three-fourths of an inch wide. The walls of this cavity were formed by cicatrized liver tissue. Section of the neighboring liver showed an insignificant amount of cicatricial tissue. A profuse amount of pus typical of liver disintegration had been discharged daily for months in the expectoration and by drainage from the thoracic cavity. Death finally resulted not from liver or lung infection, but from infection (abscess) of the brain. In another case (Case XI) recently observed, giving a typical history of hepatic abscess with pleural and pulmonary involvement associated with expectoration of large quantities of chocolate pus, the lower portion of the pleural cavity and the upper surface of the diaphragm were fully exposed to view by an extensive excision of the chest wall. No trace could be found of a liver abscess, although a most minute search was made. The pleural cavity contained a large quantity of thick, white pus mixed with masses of chocolate colored pus. We were also unable to find the opening from the pleural cavity into the lung. As this case recovered it is within the bounds of possibility that our observations may be incorrect. A similar case is quoted by Marion.

We have strong evidence pointing to transference of the amoebic infection from the liver to the lungs, for Lafleur and others have shown that the walls of the pulmonary cavities contain amoebæ, and they ascribe the extensive destruction of the lung to the agency of these organisms. It is impossible to explain the persistence of the symptoms and the extension of the ulceration by any other hypothesis. I have been able to collect some cases that seem to me to admit of no other interpretation. Such are the cases reported by Roch, Suzuki,

Cantlie, Godlee and others, in which the presence of a liver abscess was clearly demonstrated as the primary infection either at autopsy or during life. In each one of these cases the liver abscess had healed up and the cause of death was abscess of the lung. Marion and Natton-Larrier have reported cases of amœbic abscesses of the lungs in which the symptoms pointed strongly to hepatic abscess as a primary condition, but in which no liver abscess could be demonstrated at the time of operation. Appended here are short résumés of the cases mentioned above:

I. INFECTION OF THE LUNGS BY DIRECT INVASION.

ROCH reported a case in which the liver abscess penetrated the diaphragm and chocolate pus was expectorated. Death finally occurred from exhaustion. At the autopsy there was only a cicatrix to show the site of the liver abscess. The entire base of the right lung was occupied by purulent cavities.

SUZUKI mentioned a case of successful operation for hepatic abscess following dysentery. Eight months later an abscess formed in the upper lobe of the right lung, which was opened successfully.

CANTLIE reported a case of successful operation on a liver abscess. Six months later empyema of the right pleural cavity developed. After draining, the patient died. Autopsy showed an abscess in the upper lobe of the right lung. The liver abscess had healed completely.

GODEE: Three such cases are reported by Godlee.

(1) CASE 8.—A patient spitting up chocolate-colored pus was operated upon and an abscess in the base of the right lung opened. The finger was passed through the diaphragm into an abscess cavity in the liver. Two months afterward the patient died from haemoptysis. The autopsy showed irregular cavities in the right lung, but that in the liver had healed up.

(2) CASE 9.—A patient with abscess of the liver began to spit up chocolate-colored pus. Eventually, an abscess in the base of the right lung was opened on two occasions. Death occurred from abscess in the brain. The autopsy showed little or nothing to indicate the old abscess of the liver.

(3) CASE 10.—A patient with abscess of the liver developed signs of an abscess at the base of the right lung. This was opened and drained. He eventually died from an abscess in his brain. The autopsy showed an extensive abscess in the lung, but nothing except adhesions between the liver and diaphragm to indicate the old abscess in the liver.

MARION reported a case of abscess of the lung, with profuse expectoration of pus containing no other organisms except amœbæ. The patient had suffered from several attacks of amœbic dysentery. Abscess of the liver was suspected but not found either by aspiration or at operation. Resection of ribs revealed adhesion of lung to diaphragm, but no abscess

in the liver (compare our cases). An amoebic abscess the size of an orange was found in the lower lobe of the right lung. The patient recovered.

NATTON-LARRIER reported a case of a patient with a history of dysentery, who developed an amoebic abscess in the lower lobe of the right lung. During operation for draining the liver abscess, no affection of the liver was discovered. The patient recovered.

2. INFECTION OF THE LUNGS BY EMBOLISM.

Compared with direct invasion, infection by this route is very infrequent. Many reported cases are open to serious doubt because of the carelessly conducted autopsies. Others must be accepted unequivocally.

The one reported by Colin is typical of this condition. A patient with abscess of the liver died with symptoms of intense dyspnea and asphyxia. The autopsy showed an abscess of the liver which had opened into the ascending vena cava. Scattered abscesses were found in both lungs.

LAFERRÉRE reports a case of abscess in the left lobe of the lung consecutive to one in the right lobe of the liver.

BUNTING mentioned a case of amoebic abscess of the liver with no involvement of the diaphragm or pleura, in which an abscess cavity was present in the upper lobe of the right lung. There were absolutely no signs of direct extension of communication between the two abscesses.

On reflection it is rather remarkable that this mode of infection should be so rarely encountered. Perhaps the low intensity of the inflammation, the extent of fatty degeneration in the liver tissue surrounding the abscess cavity, and the frequent absence of microorganisms other than amoebae explain the rarity of embolism; or, on the other hand, it is probable that the lungs are particularly resistant to the invasion of amoebae under ordinary conditions. That under certain conditions amoebae do pass from the abscesses into the hepatic veins and into the lungs and even through their capillaries into the systemic circulation is shown by the appearance of cerebral abscesses of embolic origin, containing amoebae. One of our cases (Case X) at autopsy showed an abscess in each frontal lobe and in the left lateral cerebellar lobe. Many such cases have been reported.

PROTHERAT reported a case of amœbic liver abscess, with purulent expectoration also containing amœbae. The patient died with marked cerebral symptoms and the autopsy showed a brain abscess containing amœbae. Kartulis has stated that brain abscesses occur in 3 per cent. of all liver abscesses.

SYMPTOMS OF PULMONARY AND PLEURAL INVOLVEMENT.

Added to the symptoms of hepatic abscess, the first sign of importance is severe pain in the shoulder. This is always a symptom of diaphragmatic involvement. It may be accompanied by increase in pain and tenderness over the lower part of the chest, which is suggestive of involvement of the lower portion of the pleural cavity. A distressing tickling or hacking cough may be present at this time, with or without any signs of pleural effusion. The symptoms increase in intensity until, without any other warning, the patient may expectorate suddenly a large quantity of chocolate-colored pus. Temporary relief of the symptoms follows and the patient may improve daily in health, if the drainage is free and if too much liver tissue has not been destroyed. When the drainage is free, pus flows without hindrance into the bronchi and is expectorated constantly. As time passes the quantity expectorated diminishes, and in some (rare) cases the abscess cavity may heal up completely and a spontaneous cure may result. In other cases drainage may be intermittent. Periods of profuse flow alternate with those of scanty flow or it may even cease for a time. During the periods of profuse flow the patient is free from pain and fever. When the flow ceases, pain and fever return again. In cases that drain poorly the outlook is serious, because the conditions favoring progressive necrosis of liver tissue are still present; and, further, the continued use of the lung as a channel for the discharge allows the amœbic infection to gain a stronghold in lung tissue and to cause extensive destruction and cavitation.

The foregoing description applies to that class of cases where adhesions between the lung and diaphragm have preceded the pointing of the abscess. Where no adhesions have formed the abscess opens directly into the pleural cavity and fills it more or less. Signs of serous effusion often antedate

actual perforation, in which event, except for an increase in the quantity of fluid, the physical signs do not alter. In such cases it is often impossible to determine the time of actual perforation, symptoms of empyema being gradually added to those of serous effusion. The change in the character of the fluid is often discovered by chance after aspiration. In the event of perforation of the abscess into an intact pleural cavity (probably very rare) very acute symptoms come suddenly. Pain and dyspnea are intense. The whole pleural cavity may fill up in a very short time and the lung may be acutely compressed. If these cases are left to Nature and the pleural cavity is not drained, the outlook is very grave. Spontaneous evacuation of the accumulation may occur through the lung or through the chest wall. The former route is probably the most frequent. Even in cases that are drained, the mortality is very high. Pus is often discharged through the chest wall and into the bronchi simultaneously and in many instances drainage of the pleural cavity fails to relieve the expectoration completely. Some cases recover, but many of them die from exhaustion. Occasionally, cavities form along the drainage track in the lung in spite of external drainage, and from them pus of a chocolate color is expectorated constantly.

FREQUENCY OF PLEURAL AND PULMONARY INVOLVEMENT.

This has been estimated variously by different writers.

Rendu, analyzing 563 cases, found 31 cases where the abscess had opened into the pleural cavity, or 5.5 per cent. Molinié stated that it occurred in 8.9 per cent. of cases; 5.5 per cent. for the opening of the abscess into the pleural cavity and 3.4 per cent. for the presence of serous effusion. Harris found the pleural cavity involved 3 times in 95 cases. Futcher, in 119 cases, found the lung involved in 6 and the pleural cavity in 3 cases. Strong, in 100 fatal cases, found the lung involved in 1 case and the pleural cavity in 2 cases.

Our cases show a marked contrast. In 27 cases we found the lung and pleural cavity affected in 11, *i.e.*, 40.8 per cent.

PROGNOSIS.—This can be more conveniently discussed under two heads:

1. The prospects of spontaneous cure.
2. The results of operative procedures.

1. *Spontaneous Cure.*—This result may be hoped for in a small proportion of cases in which the abscess penetrates the lungs directly without infecting the pleural cavity, but it probably never occurs when the pleural cavity forms an intermediary channel between the liver and the bronchus. Quite a number of cases have been reported from time to time that can be accepted without cavil as instances of real cures. Such are two reported by Vertiz, where a period of good health had elapsed, without bad symptoms, long enough to justify the conclusion that the abscesses in both liver and lung had healed. Others cannot be accepted without question. Such are two reported by Phillips, which were treated with ipecac and emetic, but were under observation too short a time to justify the conclusion that they were cured. It has been my privilege to see five cases where the abscess opened directly through the lungs. Of these only one certainly recovered (Case VII), not spontaneously, but following excision of the chest wall, and drainage of the abscess cavity. Another (Case VI) left hospital in 30 days, still expectorating chocolate-colored pus and having a septic temperature. A third (Case V) died in hospital four months after admission from exhaustion, spitting chocolate-colored pus to the last. The two others are not in the case reports, having been under observation prior to the year 1907. Both died eventually from exhaustion, with every symptom of pulmonary abscess, spitting chocolate-colored pus to the last. In only one, *i.e.*, the case that recovered, was the abscess located by aspiration. We failed signally to find the abscess cavities by the aspirating needle in all the rest.

2. *The Results of Operative Procedures.*—The mortality of hepatic abscess in general is always high. Varonoff collected 1089 cases which were operated on in Egypt, during a period of 25 years, and found a mortality of 34 per cent. in those operated on by a large incision, and a mortality of 60 per cent. in those treated with the trochar and cannula. Martin, in Cambodge, found a mortality of 37.5 per cent. Gaide, in Toulon, found a mortality of 33 per cent. The best statistics

on a series of consecutive cases is given by Cantlie. Out of 100 cases there were 82 recoveries and 18 deaths, a mortality of only 18 per cent. Of these cases 90 were treated by evacuation with a trochar and cannula (Manson's method). Our own mortality for the cases reported was, roughly, 29 per cent.

A separate analysis of the cases showing pleural and pulmonary complications reveals an enormous increase in the mortality. According to Molinié the mortality is as high as 84.8 per cent. Our own mortality for a consecutive series of cases amounts only to 45.4 per cent., but the number is small. It is my conviction that a mortality of 75 per cent. would represent an average. If every case leaving hospital could be followed up many of those discharged as improved would be found to have died of exhaustion. An analysis of our own reports will explain this statement.

I have made an analysis of our own reports since 1907, and find that 27 cases of hepatic abscess have been operated upon. The results which I have tabulated very carefully are as follows:

Cured	13, roughly,	48 per cent.
Improved	6, roughly,	22 per cent.
Died	8, roughly, a mortality of	29 per cent.

CONDITION OF THE 13 CURED CASES WHEN DISCHARGED.

No. 1 was discharged in 30 days	with normal temperature.
No. 2 was discharged in 21 days	with normal temperature.
No. 3 was discharged in 40 days	with normal temperature.
No. 4 was discharged in 3 months	with normal temperature.
No. 5 was discharged in 2 months	with normal temperature.
No. 6 was discharged in 49 days	with normal temperature. (Case VII).
No. 7 was discharged in 3 months	with normal temperature. (Case IX).
No. 8 was discharged in 44 days	with normal temperature. (Case II).
No. 9 was discharged in 20 days	with normal temperature.
No. 10 was discharged in 22 days	with normal temperature.
No. 11 was discharged in 31 days	with normal temperature.
No. 12 was discharged in 3 months	with normal temperature.
No. 13 was discharged in 30 days	with normal temperature.

None of these cases left hospital with any fever. Some had a slight discharge that required a dressing, but the condition of

all of them was practically well. Of them three (Nos. 6, 7 and 8) were complicated with pus in the pleural cavity.

CONDITION OF THE 6 CASES MARKED IMPROVED WHEN DISCHARGED.

No. 1 was discharged in 26 days. Temperature slightly elevated.

No. 2 was discharged in 24 days. Temperature septic, 99° to 102°.

No. 3 was discharged in 60 days. Temperature septic, 90° to 102°.

No. 4 was discharged in 30 days. Temperature septic, 99° to 102°.

Spitting pus (Case VI).

No. 5 was discharged in 3 months. Temperature septic, 99° to 102°.

Spitting pus (Case IV).

No. 6 was discharged in 36 days. Pleural cavity wide open and lung collapsed. Spitting up pus (Case XI).

It is evident that the condition of these patients was anything but satisfactory and some of them eventually died of exhaustion. There were *three* of these suffering from pleural and pulmonary complications (Nos. 4, 5 and 6).

DEATHS.

TIME OF DEATH AND CAUSE OF THE 8 DEATHS.

No. 1 died at the end of 4 months. Uncomplicated abscess. Died of exhaustion.

No. 2 died at the end of 48 days. Perforated the diaphragm. Opened into pleura and lungs. Very septic (Case VIII).

No. 3 died at the end of 4 months. Perforated diaphragm and opened into the lungs. Exhaustion (Case VI).

No. 4 died at the end of 28 days. Infected pleural cavity. Exhaustion (Case III).

No. 5 died at the end of 66 days. Opened into pleural cavity, and lungs. Very septic (Case I).

No. 6 died at the end of 16 days. Uncomplicated abscess. Death from peritonitis, following perforation of ulcer of cæcum.

No. 7 died at the end of 40 days. Pleural cavity and lung infected. Death from cerebral abscess (Case X).

No. 8 died at the end of 18 days. Uncomplicated abscess of left lobe of liver. Exhaustion.

It will be seen that five of the eight deaths (*vid.* Nos. 2, 3, 4, 5 and 7) occurred in cases where either the pleural cavity or lungs or both were affected, *i.e.*, 62.8 per cent. of the deaths occurred in this class of cases.

Out of the 27 cases, there were 11 with *pleural and pulmonary complications*, *i.e.*, 40.8 per cent.; of these 5 died, *i.e.*, a mortality of 45.4 per cent.

The following is a brief abstract of these cases:

CASE I.—Male; white; aged forty-nine. Abscess of right lobe of liver which had perforated diaphragm. Pleural cavity full of pus. Also coughed up quantities of pus. No amoebæ found. Drained with Manson's trochar; afterwards excision of ribs. No abscess found in liver. Continued to spit up quantities of chocolate-colored pus even after drainage. Died of exhaustion at the end of 66 days (*vid. No. 5, deaths*).

CASE II.—Male; aged twenty-nine. Abscess of right lobe of liver. Lower part of pleural cavity full of chocolate-colored pus. Amoebæ absent. Pleural cavity drained with trochar and cannula. Recovered (*vid. No. 8, cures*).

CASE III.—Female; colored; aged forty. Abscess of right lobe of liver. Right pleural cavity full of pus; chest wall edematous from fifth interspace down. Breathing labored. No spitting of pus. Pleural cavity drained with trochar and cannula. No amoebæ found. Drainage free. Death from exhaustion in 28 days (*vid. No. 4, deaths*).

CASE IV.—Male; negro; aged twenty-seven. Abscess of right lobe of liver. Ruptured into the pleural cavity and lung. Spitting up of chocolate-colored pus. Amoebæ present at first in sputum and in pus aspirated from pleural cavity, but disappeared during convalescence. Pleural cavity drained. Discharged from hospital in 3 months with septic temperature and wound in chest still draining (*vid. No. 5, improved*).

CASE V.—Male; white, aged fifty. Abscess of right lobe of liver, which had perforated into the right lung. Expectoration of chocolate-colored pus. Pleural cavity intact. Aspiration of liver failed to reach abscess cavity. Expectorated constantly. Died at end of 4 months from exhaustion. No autopsy (*vid. No. 3, deaths*).

CASE VI.—Male; white, aged twenty-eight. Abscess of right lobe of liver. Perforation into the lung. Pleural cavity intact. Expectoration of chocolate-colored pus containing amoebæ. An attempt was made to reach the pus with an aspirator, but it failed. Discharged from hospital in 30 days with septic temperature (*vid. No. 4, improved*).

CASE VII.—Male; white; aged forty-nine years. Abscess of right lobe of liver. Spitting up of chocolate-colored sputum, containing amoebæ. Pleural cavity intact. Excision of seventh and

eighth ribs. Diaphragm stitched to chest wall. Opened and drained abscess in upper part of liver. Cured in 49 days (*vid. No. 6, cured*).

CASE VIII.—Male; white; aged sixty-one years. Abscess of right lobe of liver. Perforation into the pleural cavity. Rupture into the lung and profuse expectoration of chocolate-colored pus. No amœbæ found. Pleural cavity drained. Death in 48 days from exhaustion. No autopsy (*vid. No. 2, deaths*).

CASE IX.—Male; negro; aged thirty-five years. Abscess in right lobe of liver. Perforation into the right pleural cavity. Chocolate-colored pus aspirated from both situations. No amœbæ found. Amœbæ present in the faeces. Pleural cavity drained after excision of part of the seventh and eighth ribs. Liver abscess drained through same opening. Recovery in three months (*vid. No. 7, cured*).

CASE X.—Male; white; aged forty-six. Abscess in right lobe of liver. Perforation into right lung and pleural cavity. Spitting up of large quantities of chocolate-colored pus. Amœbæ present in the pus. Amœbæ also present in the stools. Pleural cavity full of pus. Drainage of pleural cavity by trochar and cannula, followed by great improvement in general symptoms. Subsequent excision of a large part of the bony wall of the right thorax. Lung collapsed. No abscess could be found in liver. Death in 40 days. Liver abscess was practically healed. The lower lobe of right lung contained a large abscess cavity. Lung was collapsed (*vid. No. 7, deaths*).

CASE XI.—Male; white; aged sixty-two. Abscess of right lobe of liver. Perforation into right pleural cavity and lung. Expectoration of large quantities of chocolate-colored pus. Pleural cavity had been drained six months previously. Aspiration of cavity revealed chocolate-colored pus. Drainage with trochar and cannula. Slight improvement. Subsequent removal of a large part of the bony wall of thorax. No abscess was discovered in the liver. Lung was collapsed, but opening into it from pleural cavity could not be found; although fluid ran freely from pleural cavity into the air passages. Discharged from hospital in 36 days, with pleural cavity wide open and lung collapsed; also, with expectoration of chocolate-colored pus (*vid. No. 6, improved*).

TREATMENT.—Early diagnosis and prompt evacuation of the original abscess cavity is not only attended by a very low mortality, but is an effectual means of preventing these complications. A very large proportion of abscesses in the right lobe of the liver are capable of diagnosis long before they have penetrated the diaphragm, and they can be opened and drained with a trochar and cannula with every prospect of success. The cases that are difficult to diagnose and to reach with an aspirator are abscesses situated in the posterior and upper part of the right lobe near its junction with the left lobe. Some of them cause no local symptoms, except diffuse pain over the liver, until the diaphragm is involved, when pain in the right or left shoulder may be complained of. It is in such cases that sudden perforation into the lung and profuse expectoration of pus occurs so frequently. This accident sometimes happens without the patient knowing that he is suffering from liver abscess. Aspiration often fails to reveal pus in this portion of the liver, because sufficient care is not taken to search for it in the right direction and to a proper depth. Cantlie has given careful attention to the proper method of aspirating the liver and has formulated the following rules from measurements made on the cadaver. In a patient the circumference of whose body is 32 inches over the middle of the hepatic area, the vena cava inferior lies at a depth of $4\frac{1}{2}$ to 5 inches from the surface of the body, along a line drawn backward horizontally (in the upright posture) from the xiphisternal articulation in front to the angle of the ribs behind. He also found that the vena cava is equidistant from any point in the usual operative area. Aspiration should be made systematically in a horizontal direction, penetrating the liver from right to left, each successive puncture being posterior to the previous one. By this means, a larger area of liver surface is explored than can be done with punctures in different directions. Even after most painstaking and repeated aspirations, failures are very common and the abscess may eventually penetrate the diaphragm. The course to pursue after the abscess has penetrated the diaphragm depends on the pathological condition of

the structures involved. *If the pleural cavity is not infected, i.e., if the lung has adhered to the diaphragm before perforation and the abscess has opened into a bronchus through lung tissue, it is better to wait awhile to see what will happen.* Some few cases recover spontaneously. The liver abscess collapses and cicatrization follows, both in liver and lung. This result is only reached after a tedious convalescence and is probably a rare termination. What usually occurs is that the abscess fills up and empties itself intermittently, because for some reason the track through the lung becomes blocked or obstructed from time to time. A persistence of this condition is likely to terminate in infection of the walls of the pulmonary track with amœbæ, which in turn will result in destruction and cavitation. Two cavities will then be present, one in the liver and the other in the lung, communicating with one another. Finally, that in the liver may heal up completely, but the cavitation persisting in the lung may extend and prove fatal. An accurate estimate of the true anatomical condition of the infected cavities is rarely possible. It is, however, necessary to bear in mind always that, at the time the case comes under observation, there may be no longer any abscess cavity in the liver. It is easy to understand why so many failures to reach the abscess cavity have been recorded. Even in cases where the abscess cavity in the liver still exists, it is practically hopeless to reach it while expectoration is free and profuse, because the walls are collapsed and the cavity is very small. The only time when aspiration is justifiable is when the expectoration ceases and the patient is febrile (*i.e.*, when the abscess cavity is full). Even under these circumstances successful aspirations are rare. Still, it is probably the best course to pursue and repeated attempts should be made before abandoning this method as not feasible. If aspiration fails an attempt may be made to reach the collection (1) by the abdominal or (2) by the transthoracic route. The abdominal route is hardly advisable in abscesses penetrating the right lung, because it is impossible to get within a reasonable distance of the point of perforation. Cantlie advises it strongly in abscesses of the left

lobe. Through an incision in the left rectus the hand is thrust into the abdomen and the area of adhesion between the liver and diaphragm palpated. An aspirating needle is now thrust through the lower intercostal spaces in the direction of the abscess, being guided in its direction by the fingers in the abdominal cavity. The transthoracic route has been condemned because it may endanger the integrity of the pleural cavity. If conducted carefully by the method of Lannelongue, the cartilages of the seventh, eighth and ninth ribs can be removed and a large area of the upper surface of the liver uncovered by diaphragm can be rendered accessible. McLeod insists that a transthoracic operation is the only logical route, and bases his argument on the contention that the pathological focus in most cases is in the lung and not in the liver, because in this stage the liver abscess has healed up. It appears to the writer that this contention is well sustained by many post-mortem examinations, and that well conducted transpleural operations offer the best prospect of ultimate cure. The cases reported by Godlee support this position strongly.

If the pleural cavity is infected the problem becomes less complicated. It should be opened at once and a drain inserted. If necessary a segment of one or more ribs should be excised. If the condition of the patient allows it, the upper surface of the diaphragm should be examined and, if possible, the opening into the liver abscess found, enlarged if necessary and the cavity drained. Prompt attention will often save the lives of some of these patients. Collapse of the lung is often present and in old standing cases it is very unlikely that a great deal of expansion will follow even after decortication operations. A large number of these patients die sooner or later from exhaustion. In some instances the pleural cavity may contain pus which is being discharged into the lung and coughed up. As described above, the pleural cavity may be a reservoir and the lung tissue serve as a track or sinus along which the pus passes. On the other hand, the pus may pass from the pleural cavity into a lung cavity and thence into a bronchus. As previously stated, the liver abscess may be present or may have healed

up. Such cases are almost hopeless. Even where no lung abscess is present the prospects of permanent cure are very slight. In the presence of a lung abscess, cure is very improbable. Still, we should do all we can. The lung abscess should be opened and drained; likewise, the liver abscess if it exists.

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THE CAUSAL RELATION OF TRAUMATISM TO TUBERCULOSIS.*

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THE Courts of Philadelphia and, I doubt not, the Courts elsewhere, are at times obliged to consider the question of the relation of trauma to tuberculous lesions—pulmonary, glandular, osseous, and articular.

The law is often an organized and methodical bewilderment. Lawyers are professional bewilderers who are occasionally accurate and truthful and then not always from virtue, but sometimes perhaps from necessity or deep design. They raise a cloud of dust to obscure the facts and then vainly try to find a way out. The Judge may be a self constituted oracle of surgical knowledge, an irritable repudiator of everything modern and reasonable, or he may sit in dignified isolation from all mundane annoyances and all irritating and contaminating truths. Medical witnesses are often partisan and controversial, are not very unusually inaccurate and unreliable, and are sometimes actually mendacious. Some of them cheerfully swear to things they would not bet on. The elder Dumas said that it is the book which it is impossible to read which creates a sensation. The same may be said of dinners it is impossible to eat, and of testimony it is impossible to understand. In the average damage suit there is much contradictory testimony from medical experts. Some of the testimony may have as little meaning as the frozen words which fell upon the deck of Pantagruel's ship. The Judge and jury, even if instigated by the best intentions, may pass into the deepest error and so the wrong may triumph. Surely a more stupid method

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of seeking truth and hence of obtaining justice could scarcely be devised. Such views will not be popular with lawyers and professional medical experts, but in the words of Paul to the Gallatians, "Am I become the enemy because I speak the truth?"

In a Philadelphia case, in which it was claimed that the plaintiff suffered from traumatic tuberculosis of the lung, the learned judge, apparently indignant at the mere mention of such a thing, directed the jury "to exclude all evidence touching the question of traumatic tuberculosis as fully and conclusively as if none had been offered," maintaining that "the attribution of tuberculosis to trauma does not rise above the grade of a theory adopted by a small number (a most respectable number it is true) of one profession."¹ The judicial light above quoted calmly settled the whole question off-hand and without mental effort, and decreed that hereafter traumatic tuberculosis was to have no standing in court. Lawyers express surprise that medical experts ever disagree. Lawyers always disagree. There is at least one on each side of every case, the judge often disagrees with both of them, and the Supreme Court, which has the last guess (by a majority vote), often reverses the verdict of the lower court. In the case cited above, the Superior Court of Pennsylvania disagreed with the trial judge and reversed the judgment, declaring that the testimony relating to traumatic tuberculosis "should have been submitted to the jury for its consideration."² The Court said: "There is a clear distinction between the guess and conjecture that is inveighed against by some judges and some text writers, and the carefully formed opinion of capable, honest and eminent physicians."³ In the trial of the case one expert testified that a man has eleven ribs. As Mark Twain said of Fennimore Cooper—he dealt "freely in important omissions." Perhaps he was seeking to justify the narrative in Genesis which tells of the creation of Eve. In the second trial a new medical witness was discovered by the defendant. He swore that he had attended the plaintiff three years before the accident and had a record of the case in his case book, and that long

before the accident the claimant was the victim of pulmonary tuberculosis. In the first trial one expert swore that the relation between the injury as a cause and the existing condition of the patient was obvious, and unhesitatingly affirmed that the tuberculosis was caused by the injury. In the second trial some of his views had undergone a sort of benevolent assimilation from the outside. His revised statement was that nothing in the case independent of the history could lead him to regard the condition as "traumatic consumption." The judge in his charge attached great importance to the testimony of the witness who swore that he had attended the plaintiff long before the accident and had attended him for consumption, yet the jury brought in a large verdict for the plaintiff.

Such are some of the confusions relating to this subject. Such are some of the vagaries of judges, attorneys, expert witnesses, and jurors.

Because of the unsettled opinions and divergent views made evident by the case cited above it seems worth while to review and bring together what we do know about the alleged relationship between trauma and tuberculosis—to try to discriminate between known facts and wild guesses, between reasonable deductions and fanciful conjectures. The question is as follows: Is an injury ever a determining cause of a tuberculous lesion? We all know that tuberculosis may follow injury, but that one thing follows another thing is no proof that the first was the cause of the second. To prove that tuberculosis can result from an injury we must prove that injury has a tendency, under certain conditions, to determine lesions of tuberculosis.

Until 1882 the opinion was general that injury was causal of what they then called a scrofulous joint, a strumous joint, fungous arthritis or white swelling.

Erichsen⁴ expressed the general view. In speaking of "strumous" joints he says: "This condition has not in many cases any definite starting point but appears slowly to supervene upon some slight injury, as a twist, or blow, or strain;

at other times it commences with a subacute synovitis, assuming its peculiar characters by occurring in a strumous constitution and is especially liable to happen in children and females." Samuel D. Gross⁵ was one of the very few to emphatically deny a local origin of tuberculous joints. He considered the exciting causes to be "very obscure, if not utterly inscrutable. The surgeon is often told that the patient, perhaps weeks or months before the appearance of the characteristic phenomena, received some injury, as a blow, fall or kick, or that the affected joint had been sprained, bruised, or twisted, but such information is usually not trustworthy, or if such an occurrence did take place, it probably exerted little, if any, influence in developing the complaint." Gross named many conditions as predisposing causes, saying: "Whatever has a tendency to enfeeble the system or to derange the blood are so many predisposing causes of the disease, if they do not actually call it into activity." Among these alleged causes he mentioned typhoid fever, measles, small-pox, scarlatina, chronic diarrhoea, protracted courses of mercury, copious and repeated hemorrhages, chronic digestive disorder, unwholesome food, poor assimilation, imperfect nutrition, and infantile cholera.

We know in this day that some of the conditions mentioned by Gross did not produce tuberculous joints, but did produce special forms of joint disease not then identified. This is true, for instance, of typhoid fever. The other conditions could favor the development of tubercle in the body by lowering general body resistance but could have no power in determining its location in bone, joint or pulmonary tissue.

Max Schuller's⁶ widely quoted experiments were made in 1880. They seemed to indicate the tuberculous nature and the frequent traumatic origin of "strumous synovitis." Schuller performed tracheotomy upon dogs and rabbits, injected tuberculous material through the tracheal openings and at the same time injured the right knee-joint of each animal. As a result some of the animals developed general tuberculosis and some a condition that appeared histologically to be tuberculosis of the damaged joint. In no instance did a joint which had not been injured become tuberculous.

Gibney, in 1877,⁷ asserted that traumatism was causal in forty-two per cent. of his cases of joint tuberculosis.

Koenig⁸ maintained the causal influence of trauma in at least half of the cases of tuberculous joints.

Téissier⁹ believed that an injury of the chest followed by haemoptysis might be responsible for the development of pulmonary consumption.

According to Oliver,¹⁰ Perrond in 1875 claimed that the frequency of phthisis among the boatmen of the Rhone was due to the men "leaning with their chest wall upon the pole of the rudder in steering their ships. It was thought that the repeated pressure favored the development of pulmonary lesions, the interesting point being that the maximum focus of the disease, as revealed by auscultation, always appeared to be located at the level of the point of pressure by the pole, viz., under the right clavicle."

In 1882 Koch discovered the tubercle bacillus and this discovery strengthened the belief of all who denied the influence of traumatism in the production of local tuberculosis. They said: "the disease can be caused by the bacillus alone. Traumatism cannot cause the bacillus. Hence injury is casual, never causal."

W. Müller,¹¹ experimenting on the bones of goats, injected tubercle bacilli into the nutritive arteries without inflicting trauma on the bones and tuberculous osteomyelitis developed. This seemed like experimental proof of what every one knew, that the condition could develop without trauma. Lannelongue and Achard¹² injected tubercle bacilli into guinea-pigs and in from nineteen to twenty-one days later produced bone injury and joint damage, yet tuberculous disease did not arise in the damaged areas. In these cases the injuries were inflicted at too late a period after injections.

Friedrich¹³ actually asserted that joints subjected to traumatism were less likely to become tuberculous than uninjured joints. Some corporations would be glad to pay money to have this view petrified into established law. It is worthy of note that Friedrich used attenuated cultures in his inoculations.

Frazer¹⁴ by injecting bacilli into the nutritive arteries did not produce tuberculous osteomyelitis. Krause¹⁵ injected guinea-pigs and rabbits with pure cultures of the bacilli. At the time of the injection or very soon afterwards, he broke a bone and injured a joint. In no case did the seat of fracture become tuberculous. In one-third of the guinea-pigs and one-half of the rabbits the injured joint became tuberculous. In only one case did a joint which was not injured become tuberculous.

Salvia¹⁶ injected rabbits with virulent cultures and claimed that injury localized tubercle. Animal experiments are inconclusive and contradictory.

Drs. H. A. Wilson and Randle C. Rosenberger¹⁷ say, "it is impossible to accurately compare animal experiments with the process as seen in human beings, for the reason that the means of infection employed in animals essentially differs from the infection of children. Animal experiments are wholly artificial, and necessarily so. Direct inoculation of a child's joint does not occur, nor is trauma of any kind ever applied in the manner resorted to in experimentation. The results of animal experimentation are therefore interesting, instructive, and illuminating, but

too much reliance should not be placed upon them in determining a solution of the problem. Very little information is obtainable as to the kind of trauma that was employed in the experiments. It is impossible, therefore, to determine the relative value, as causative or contributory factors, of severe injuries, sprains, contusions, lacerations, bruises, indirect trauma and functional trauma."

At the present time some surgeons absolutely deny any relation between trauma and tuberculosis. Richard Stern¹⁸ states that most surgeons, judging from clinical experience, deny that trauma is concerned in the development of osseous or articular tuberculosis and that if it appears to be, the bone or joint was previously tuberculous.

Nicholas Senn¹⁹ in 1892 affirmed with emphasis that trauma can only be an exciting cause of tuberculosis of bone in a person "already infected with the essential cause." He did not say that a person must have a lesion of tuberculosis. He states specifically that the *bacilli* must be present in the *tissue* or in the *blood* at the time of the injury.

Wilson and Rosenberger²⁰ emphatically deny that trauma has any "existence in the etiology or in the beginning of the process" in bone or joint tuberculosis.

Many surgeons still affirm a relationship. All admit that a local quiescent focus may be lighted up by an injury. Nobody believes that injury under any circumstances causes the bacillus. Nobody believes that injury without the bacillus is under any circumstances capable of causing those tissue changes which we call tuberculous. What many do believe is that injury may determine the development of tuberculosis in a part previously free from lesion. Among the many surgeons who believe that injury may determine the development of tuberculosis we may mention Bradford and Lovett, W. Watson Cheyne, Nichols, Bryant, Sir Frederick Treves, Tillmanns, Golthwaite, Voss, and H. L. Taylor. Many medical writers never speak of the matter at all. Jacoud of Paris²¹ in 1896 reported a case of phthisis which he believed to be due to traumatic pneumonia. Weir of Glasgow²² reported a case of a man who was struck on the chest and developed pleurisy and finally phthisis. Some call this contusion tuberculosis.

Oliver²³ has seen cases which suggest "a causal connection between injury and tuberculous lung disease." Other observers have been convinced that tuberculous meningitis can follow a head injury (Waibel,²⁴ Ehrnrooth²⁵). Traumatic tuberculosis of the breast and traumatic tuberculosis of the kidney have been described.

The relationship between injury and tuberculosis has been a subject of considerable debate in Germany since the promulgation of the workmen's compensation law in 1884. The new state insurance act must bring it to the front in England.

In the United States a horde of eager damage suit lawyers and a number of reluctant corporations are wrangling the

question into prominence. It behooves surgeons to study the matter, to think it over with care and to reach definite conclusions.

In the ensuing discussion I shall consider particularly tuberculous bones and joints. Joint tuberculosis is the condition in which the relation between trauma and tuberculosis seems to be closest.

Tubercle bacilli are particularly prone to take lodgment in and produce disease of cancellous tissue. The period of greatest liability is during the first decade of life, particularly during the first five years, though during the first year the disease is rare. Considerable more than half of the cases occur before the twentieth year. Many cases occur in persons much beyond the twentieth year, middle aged victims are not rarities and even the senile are not immune. Sir James Paget saw a case in a man of ninety-one. In the first decade the condition is about equally common in males and females. After the first decade up to the age of sixty it is most common in males. After sixty the disease is equally common in both sexes. Hereditary predisposition is often noted in children. It is found in at least twenty-five per cent. of them. Inherited predisposition is far less commonly evident in adults. The prognosis in adults is decidedly worse than in children, suppuration is more apt to occur and sequestrum formation is a more usual consequence.

Howard Marsh says,²³ "Indeed recovery, when either the hip or the knee is attacked in patients between thirty and sixty-five, very rarely takes place." The prognosis is worse in males than in females. Death may be due to acute general tuberculosis, to tuberculosis of distant parts (lung, brain, genito-urinary organs, peritoneum), to exhaustion, or to lardaceous degeneration. Of W. Watson Cheyne's cases²⁴ only 4.4 per cent. died of tuberculous disease and only 10.8 per cent. suffered from phthisis or tuberculosis elsewhere.

In cases of bone and joint tuberculosis *demonstrable* tuberculosis of the lung is rare, in fact, the victims of supposedly primary tuberculosis disease of a bone or joint seldom develop active pulmonary tuberculosis.

Howard Marsh²⁵ says, "At the Alexandra Hospital, where there are always between sixty and seventy children under treatment for hip disease, and where the subsequent history of the case is, as far as possible, traced out, phthisis is so rare that sometimes a year passes without the development of more than two or three examples of it."

If tuberculous lesions exist in the lungs they are usually in "a comparatively dormant or recessive stage, and in the vast majority of instances do not progress, but clear up and disappear under treatment—and *pari passu*—with the improvement of the bone and the joint." (Woods Hutchinson.²⁶)

Old foci, often latent or regressive, may exist in the lungs or in lymph-glands. Cornet²⁸ tells us that out of 67 autopsies made by Orth in Gottingen, 53 showed distant foci but 14 cases were found free from any focus beyond the bone and joint.

Which joint is most commonly attacked? Most writers say the spine. During the 15 years, from 1885-1899, 7841 cases were treated at the Hospital for Ruptured and Crippled in New York City. Of these 3203 were instances of Pott's disease, 2230 of hip disease and the remaining 2408 cases comprised tuberculous disease of the other joints (quoted by Weeks²⁷). The lower suffer much more frequently than the upper extremities. Age is certainly a factor in determining localization.

In early childhood hip disease is most common, but the knee runs it a close second. The shoulder is seldom attacked during the first decade. The hip seldom during the third decade and very seldom during the fourth decade.

W. Watson Cheyne²⁸ arranges "the various bones and joints in the following order of frequency of occurrence, from youth upward: hip; knee; ankle and elbow; tarsus; fingers; spine; shoulder; wrist; ribs. In order of frequency of occurrence during the first decade we have—hip; knee; spine; elbow; ankle; tarsus; fingers; wrist.

Statistics show that a considerable and perhaps a very large per cent. of all cases are preceded by injury and suggest that not a few cases in reality are directly determined by injury. Some surgeons have assigned injury as a cause in 53

per cent. of cases (C. F. Taylor, quoted by Wilson and Rosenberger¹⁷). Others have restricted the number of traumatic cases to 10 per cent. Whitman²⁰ combined the statistics of Koenig, Mikulicz, Bruns and Hildebrand, and thus obtained 3398 cases, 513 of which were described as traumatic.

Ribera Y. Sans²⁰ finds a record of antecedent trauma in 45 per cent. of cases of tuberculosis of the larger joints.

Koenig⁸ believed that distinct traumatism preceded the disease in 50 per cent. of cases. Voss²¹ set the percentage at twenty.

Bosanquet²² says: "I think we must put disease of the joints in a class by itself. There is a considerable mass of evidence, that in some way or other injury does lead to tubercular arthritis." All statistics indicate that slight injuries are more often blamed than severe injuries. It is not a dislocation of a joint which is thought to be causal, but a sprain of a joint or a contusion of a ligament. It is not a fracture of a bone but a bruise of the periosteum or a strain of an epiphysis. Treves²³ says: "Another feature in tuberculosis is the trifling nature of the irritant or lesion whereby the mischief may be in the first place localized."

Statistics show conclusively that recognized trauma often precedes the disease. That trauma often precedes the disease does not prove that it causes the disease. The sequence is not of necessity a consequence. In order to prove that it is a consequence we must prove from known facts and justifiable deductions that an injury has a definite tendency to determine the development of the disease in a bone or in a joint.

All admit that a great number of cases arise without any record or sign of antecedent traumatism or preceding joint disease. This is thoroughly proved by such recorded cases as the following. A boy while in bed and under treatment for tuberculous disease of one hip developed the disease in the other hip.

A person in apparently robust health may develop the disease. Bonney²⁴ says: "I have had occasion to note in a rather surprising number of cases the so-called idiopathic development of tuberculous processes in bones and joints among adult robust farmers and others accustomed to physical activity in the open air."

All acknowledge that if there is an existing active focus of

bone or joint tuberculosis an injury may aggravate the local condition and even disseminate the disease. An injury may prolong an illness, may convert a case tending to cure into a case tending to joint destruction or may convert a curable condition into a fatal malady.

The great importance all surgeons attach to rest in the treatment of tuberculous joints indicates the general conviction that even trivial traumatism may be detrimental or actually dangerous.

Forcible movement of a tuberculous joint is apt to be followed by articular destruction or the development of distant lesions. The patients who are not kept properly at rest are most apt to develop tuberculous meningitis or mixed infection of the joint.

All admit that a tuberculous lesion of a bone or joint may become latent and that such an arrest of the activity of a lesion is a long step on the road to cure. No one denies that an injury may light up into violent and perhaps destructive progress an area previously quiescent. Just this course of events is sometimes noted when a stiff joint containing latent foci of tuberculosis is subjected to forcible straightening. So far there has been no dispute. We have now reached the parting of the ways of opinion.

One school of surgical thought holds that osseous and articular tuberculosis is never primary, but is always secondary, and that when it is discovered after an injury, the injury was not in any sense causal of the disease, but merely aggravated a part already actively tuberculous or excited latent areas contained in the part into activity. In other words, it teaches that such a part was tuberculous before the accident and that the injury simply revealed an area of tuberculosis whose existence was previously unsuspected, or made more active an area of disease.

The other school holds that, while in most instances the disease is secondary in some it is certainly primary. It admits that in many cases the injury has merely aggravated a tuberculous lesion or awakened from dormancy a latent area, but

claims that in some cases injury is the direct determining cause of the disease. In such cases the part was free from all tubercles before the accident but quickly developed them afterwards. In such cases tubercle bacilli but not tubercles were in the part at the time of the accident or were brought there soon after it in the body fluids, such bacilli coming from some distant and probably unrecognized area of disease or having entered into the lymph and blood directly after ingestion, inhalation or inoculation. How can an injury be responsible for determining the development of tuberculosis of bone or joint?

Various bacteria by various routes are ever entering into the body fluids. If the individual is in sound health they seldom live long in the fluids. Unless the number introduced is inordinately great, the bacteria are peculiarly malignant, or the defensive apparatus of the body is impaired in efficiency, the bacteria do no harm and are soon killed. Some organisms and some spores may, of course, become latent (typhoid bacilli, pneumococci, staphylococci, spirochaetes), but as a general rule bacteria are soon killed when the individual's health is good and when they reach no area of tissue damage.

Vital resistance may be lowered generally. A number of organisms might produce no effect on a healthy man yet produce disease in a person ill-nourished, weak, debilitated by alcohol, diabetes or Bright's disease, shaken by fear or depressed by shock.

Vital resistance may be lowered locally. This may be brought about by disease, as when bronchitis lowers pulmonary resistance—or by injury, as when a haematoma becomes the seat of suppuration. A local region of lowered or impaired resistance is called *a point of least resistance*.

Injury ruptures vessels. In a slight injury a few very small vessels are ruptured, trivial and transitory hyperæmia arises and little or no stasis follows. Stasis occurs after more severe injuries but even when stasis occurs the area of stasis is surrounded by a zone of hyperæmia. If blood contains bacteria, then hyperæmia, which is a condition in which more

blood passes through the part, means that more bacteria are brought to the part, and many of them pass out into the perivascular tissues through the ruptured vessels.

Bacteria which enter the damaged tissues linger and tend to remain. Bacteria while lingering may pass out through the damaged vessel walls into the perivascular tissues. Hence an injury causes bacteria which are in the blood to linger in the region of damage and causes many of them to leave the vessels and enter as prisoners into the tissues. When bacteria linger they are dangerous—when they enter the tissues they are menaces. Instead of being carried rapidly by the part, as would have been the case had there been no injury, they make a prolonged stay in the damaged area; during the prolonged stay, which was invited by the traumatism, they have time to batter down cellular resistance by means of their bacterial poisons.

It is well known that bacteria, which when in a part but a brief time do no harm, produce disease if retained. Nacrede³⁴ says: "Wegner and Grawitz have shown that the same number of germs, which when introduced into the peritoneal cavity will cause no trouble, because quickly removed by absorption, will produce a septic peritonitis if sterilized water be added to the pure culture. This so increases the bulk that a longer time is requisite for absorption, and hence a longer time is provided for the toxic substances to act locally; moreover, the inflammation usually starts at the point of original trauma, *i.e.*, the hypodermic needle puncture, the locus minoris resistitiae."

Many years ago Chauveau pointed out that if a vein were injected with putrid fluid and a testicle crushed, the gland became the seat of septic gangrene.

Kocher showed that if an animal is fed upon putrid meat disease of bone does not arise unless the part is subjected to traumatism. If a bone is injured osteomyelitis is very apt to occur.

Nancrede³⁴ says: "The proof of these statements has been demonstrated by introducing into the circulation large numbers of the pyogenic cocci causative of osteomyelitis, whence

they quickly disappear by means such as have been already, or will be later, explained. Repeat the inoculation, however, and then contuse or fracture a bone and promptly the microbes will be located and osteomyelitis will develop."

Every surgeon is familiar with the fact that osteomyelitis without a wound frequently follows traumatism and does so when there was no antecedent purulent focus in the bone. He is accustomed to search for a distant focus from which the cocci might have come. Sometimes he finds no such atrium of infection, at other times he finds a pyogenic focus in the pleura, the lung, the ear, the mouth, the tonsil, the prostate or the skin.

Nancrede³⁴ says, "A carious tooth, the lesions inflicted on the gums by the tooth-brush or tooth-pick, burns, scalds and damages of the buccal mucous membrane caused by the teeth, lesions of the nasal passages, and recently healed wounds, may any of them be the entrance point of microorganisms productive even of fatal pyemia."

The surgeon never doubts that the bone injury determined the origin of the osteomyelitis, not by causing the creation of pyogenic bacteria, but by creating a point of least resistance, where organisms which previously passed through linger or lodge. Because of the trauma organisms which would have proved futile for harm and would have gone to rapid destruction live, multiply and produce disease.

In 21 of Hahn's 41 cases of vertebral osteomyelitis there had been antecedent traumatism and in six of these cases Hahn regarded traumatism as certainly the cause.

Acute infectious arthritis of the hip is usually determined by injury. The colon bacillus does not harm the appendix unless that part is congested or obstructed, kinked, twisted or bruised. When resistance is thus lowered the colon bacillus causes appendicitis.

In typhoid the germs enter the blood and may remain there for some time. They tend to lie latent perhaps for a very long time in bone-marrow and yet may never cause disease. Traumatism will be followed by typhoid osteomyelitis. Trauma

during or after typhoid may be responsible for typhoid spine. Traumatism of a bone in a syphilitic is followed by periostitis due to spirochætes. It is well known that empyema may follow contusion of the chest. That pyogenic cocci and various other microorganisms act in this way is not disputed. Is it unfair to assert that tubercle bacilli act in exactly the same way? They are so widely distributed, are so frequently taken into the body and are so hard to kill it would seem odd if they did not.

In fact, tubercle bacilli *do* act in the same way. They may enter blood and lymph from an active focus of disease, from a passive focus of disease, or directly by inhalation, ingestion, or inoculation without inducing disease at the point of entrance and when no known focus of disease exists. Latent lesions are most common in the bronchial and mesenteric glands, they tend to cure but may be raised into activity by some bodily disease or some injury. Even when not so goaded they may from time to time give bacteria to the system. We can seldom know that a latent lesion exists. Such a lesion is probably tuberculosis advancing toward cure.

Ravenel, Orth and others have shown that tubercle bacilli may pass through the wall of a normal intestine without causing any tell-tale lesion at the point of passage and may produce tuberculosis in the mesenteric lymph-glands or may remain latent in the nodes for a brief or for a considerable period of time. Bacilli may lie latent in glands even when the glands are not diseased. They are very tenacious of life. The fatty material or wax of the bacilli "has the faculty of resisting, in a special manner, the influence of the digestive juices, of the phagocytes, the cells which exterminate dangerous microbes, and are therefore defenders of the animal organism."²⁷

Living bacilli have been found in the faeces of apparently healthy subjects. "It would seem rational to believe that the faeces, at least, would contain occasional tubercle bacilli carried into the mouth with the food or air, and thence into the digestive tract without infecting the patient." (Wilson and Rosenberger.²⁷) Rosenberger has knowledge "of at least two

cases in which we have found bacilli in the faeces, and in which, at autopsy, no macroscopical lesions of tuberculosis could be detected throughout the body. This does not mean, of course, that the patient may not have had an actual infection by tubercle bacilli at the time of examination of the faeces and the discovery of the bacilli." ²⁷

Various observers tell us that at ordinary temperatures the bacilli will live and remain virulent in water for several months (Rosenau ²⁷). They will live much longer and freely travel in blood and lymph and may never induce tuberculous lesions.

That they can live in blood has been proved. They can enter the blood from the food by way of the lymph taken up from the intestines. They may enter the lymph from inoculation and perhaps from inhalation, and from the lymph they enter the blood. They may enter the blood from an active or latent focus of disease. If soup containing tubercle bacilli is given to animals the bacteria reach the blood of the heart within five hours (Besanti and Panisset).

In what Landouzy ²⁷ called typhobacillosis, the blood contains tubercle bacilli in numbers. They produce a septicæmic condition with positive symptoms, yet there may be no tuberculous lesion. If blood drawn from the vein of such a patient be injected into a guinea-pig the animal will develop tuberculosis.

The blood, even in a person devoid of any tuberculous lesion, must at times contain tubercle bacilli, which may linger long before dying, which may get into a gland or some other structure, there to remain latent or to induce disease. Tubercle bacilli have an affinity for special parts and tend to settle out into them (cancellous tissue of bone, lung, kidney, lymph-glands, and serous membranes). An injury tends strongly to localize bacteria. This is especially true of injury to certain bones. The lung is particularly predisposed by catarrh. The bone is particularly predisposed by trauma.

Slight injuries predispose much more decidedly than severe injuries. Volkmann called attention to this years ago. Rose

and Carless³⁵ say that the bacilli find "a suitable breeding ground" in "bones and joints in a state of congestion resulting from slight and overlooked injuries." When a few small vessels are ruptured or thrombosed, when trivial hyperæmia arises and the vital activity of an area of cells is lowered, and when the bacilli are caught in the area, they will be apt to multiply and cause disease. In such a trivial injury says Nancrede,³⁴ "The hyperæmia is too limited to admit of the prompt arrival and accumulation of phagocytes and alexins." A severe injury "is productive of such cell-proliferation that it will hold in abeyance the pathogenic action of the bacilli which might reach the seat of injury with the extravasated blood." (Senn.¹⁹) After a severe injury the more prolonged hyperæmia permits of a prompt arrival of phagocytes and alexins. In a severe injury retardation and stasis become marked and in this condition phagocytes in numbers and germicidal materials pass into the perivascular tissues. Traumatic cases are commoner in adults than in children. Traumatic cases give a worse prognosis than non-traumatic cases. Disorganization is more common, mixed infection is more usual and dissemination is more apt to take place.

In a case of tuberculous arthritis, if the reality of the accident is proved, if from the time of the accident there continued to be some pain and stiffness in the part and if the symptoms suggestive of tuberculosis arise at a period not over three months from the accident we are justified in regarding the trauma as having been causal (Bosanquet³²).

When a surgeon suspects the existence of a tuberculous joint he should always have an X-ray picture taken. Changes will be visible when the bacilli have attacked the blood-vessels and have produced nodules which destroy the medullary tissue.

In young children when the extremities of the bone are cartilaginous the X-rays will not be nearly so valuable in aiding early diagnosis as they are in adults. Whenever bone destruc-

tion has occurred the X-rays will show disease. The significance of bone changes should be interpreted by an expert.

The fact that not very unusually joints when skigraphed very soon after an accident show no trace of tubercle and yet in a few weeks or months have become obviously tuberculous, suggests, though it does not prove, that such joints contained no old foci of disease, that the injury did more than merely aggravate an active focus or rouse a dormant area and was in reality the determining cause of the joint disease. In every case of articular tuberculosis a surgeon seeks carefully for a primary focus. He may find it in a gland, lung, in the abdomen or in another articulation. In very many cases he cannot find it. In such a case there may be no other lesion or there may be a latent area. If there is a latent area it is giving no symptoms and is probably on the road to cure. An unrecognizable latent area may be raised into activity by a traumatism inflicted at the same time as the articular injury, by cold, by shock, by exhaustion, by fear, by confinement to the house, or by the development of some complicating disease. Among the objections raised to the view that traumatism may be a determining cause of articular tuberculosis are the following:

1. That a slight injury cannot be responsible when a severe injury is not. Wilson and Rosenberger¹⁷ say: "It is inconceivable that lesser injuries should do what greater injuries fail to do." Nevertheless, the statement that a slight injury does what a severe injury fails to do is true of typhoid disease of bones and joints—of osseous gummata—and of many cases of pyogenic osteomyelitis.

Bone sarcoma is more common after contusions than after fractures.

Few dispute that tuberculous thecitis may follow injury. In such a case the injury is more often trivial than violent. Why should the occurrence be inconceivable in a tuberculous bone or joint when exactly the same thing is noted, and when it is accepted in tuberculous thecitis and various other conditions? As previously stated a severe injury promptly brings quantities of phagocytes and alexins, establishes stasis which

is antagonistic to tubercle, and causes active cell proliferation.

A mild injury produces limited hyperæmia. Few phagocytes are available and little alexin arrives, there is little or no protective stasis and the tissue defences are not aroused to exert an effort at self protection.

2. Because the lower extremities suffer most often from tuberculosis but are least often injured, it is urged that injury cannot be causal. As a matter of fact, the larger joints are in the lower extremities, the larger joints are apt to suffer from slight injuries, and the larger joints are most often the seat of tuberculosis after injury.

The knee is the most common seat of supposed traumatic tuberculosis.

In some other diseases of bone and joint the same predilection is shown for the lower extremities.

The femur and tibia are most prone to osteomyelitis and I know of no denial that traumatism may be the determining cause of this disease. The same is true of typhoid disease of the bones and joints. Syphilis seldom attacks the smaller bones, but is notably common in the tibia.

3. That there are many injuries of bones and joints but comparatively few cases of tuberculous disease is looked upon by some as a conclusive fact against a traumatic origin of that disease. The argument is merely equivalent to saying that there are many winds but comparatively few shipwrecks, hence wind cannot cause a wreck—that there are many fogs but few railroad collisions, hence fog cannot be responsible for collision—that there are many falls but few fractures, hence a fall cannot break a bone.

4. The way nature protects the joints is regarded by some as indicating that slight traumatisms are unusual; for example, the knee. "In falling and striking the knee the tuberosity of the tibia receives the impact, while the patella and the entire knee escape direct injury, and yet the condyles of the femur are far more frequently the original site of tuberculosis than the tibia." (Wilson and Rosenberger.¹⁷) There are at

least three answers to this statement. In the young strain of an epiphysis is a common cause and the femoral epiphysis may be strained when the tibia is contused. Muscular or ligamentous strain may be responsible, as it is known to be in typhoid spine.

The impairment of the normal activity of the part due to the injury is responsible for trauma during functionation. This is known as "functional trauma," and functional trauma may be causal as truly as strain or contusion from the accident.

5. Some assert that as mechanical stasis tends to cure tuberculosis and as injury causes stasis, injury could not determine tuberculosis. Those who put forth this assertion should go to the logical conclusion and claim that injury of a tuberculous part would cure the disease. As a matter of fact, stasis produced by the rubber band (Bier's method) is not identical with inflammatory stasis. Further, in very slight injuries there is no stasis or very slight and temporary stasis, and it is very slight injuries which are most often to blame.

I believe that it is as certain as many things medical can be that traumatism is often a determining cause of bone and articular tuberculosis and sometimes of tuberculosis in other regions. This view is held by numbers of able and eminent clinicians and should be recognized by all courts of law.

I have seen many cases which I regard as traumatic tuberculosis of bones and of joints, and a number of cases of traumatic tuberculosis of tendon sheaths. A striking case of bone tuberculosis occurring in my practice was disease of the sacroiliac joint arising in a sturdy miner after a wrench. There was never any evidence of any other focus. Cure followed operation.

I have seen a number of cases of traumatic tuberculosis in the knee, foot, and wrist and several in the hip. I have seen tuberculosis of the inguinal glands after a kick, tuberculosis of the epididymis after a bruise, tuberculosis of the kidney after contusion of that organ, and tuberculosis of the mammary gland after a blow.

A fireman in first class physical condition fell from a roof

and fractured several ribs on the right side. Pleuritis arose, traumatic pneumonia with hemorrhage developed, and later the man died of pulmonary tuberculosis. A post mortem made by the coroner's physician disclosed the fact that the oldest pulmonary lesions were near the bruise and directly under the adherent pleura and the injured ribs. The man's family was given a pension, and in the Philadelphia Fire Department a pension is paid only when death is regarded as having been directly due to an injury.

To deny the possibility of traumatic tuberculosis is to deny many of the truths of pathology and some of the plainest lessons of clinical surgery.

The possibility of traumatic tuberculosis is a necessary deduction from acknowledged facts. To affirm it seems consistent, reasonable and, in fact, unavoidable even though the affirmation outrages the sensibilities and stirs the indignation of numerous corporation attorneys, who, in the words of Milton—"Ground their purposes not on the prudent and heavenly contemplation of justice and equity, but on the promising and pleasing thoughts of litigious terms, fat contentions and flowing fees."

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UNCOMPLICATED TUBERCULOUS FOCI IN BONES AND THEIR TREATMENT.

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THE term, uncomplicated tuberculosis bone foci, has reference to those cases in which the focus exists (*a*) as an incipient lesion, but sufficiently advanced to cause symptoms, and suggest diagnosis, (*b*) as a lesion which has resumed activity after a period of quiescence, with a renewal of characteristic symptoms. *In neither case has it become the seat of a mixed infection, nor has it invaded the adjacent joint.*

The promise of the orthopædist in dealing with lesions of this type, is based upon the belief that conservatism is his best if not only reliance.

I have always been skeptical regarding permanent cure of bone tuberculosis by orthopædic measures; rest, fixation, traction and general systemic measures. Later observation and experience have confirmed my earlier belief. In a word, I do not accept the doctrine of the final efficiency of conservatism, and have been in search of a more rational solution of a much mooted question through early, radical interference.

In a paper upon "The Operative Treatment of Hip-joint Disease,"¹ I said, "In the entire category of surgical experiences, there is nothing more pathetic and disheartening than the humiliating failures which have followed prolonged, painstaking efforts of skilful men in this department of surgery."

John L. Porter of Chicago, writing from the stand-point of the orthopædist, says,² "I doubt if there is any surgical disease which has been the subject of so much controversy, or

¹ Am. Journal Medical Sciences, July, 1905.

² Surg., Gynecol. and Obstetrics, 1913, vol. xvi, p. 334.

which has been subjected to such wide diversity of methods in treatment, as tuberculosis of joints, but it seems to me that each year brings a little more unanimity of opinion; that we find ourselves discarding suggestions of doubtful value and are treating each case in accordance with its own indications rather than by a method of fixed routine."

He maintains (*a*) that tuberculosis of joints in normal persons is a self-limited disease; (*b*) that in untreated cases the results are deformity and disability; (*c*) that the degree of deformity and disability depends upon the extent of time and duration of treatment.

As to the last factor he says that out of many hundreds of patients a few were well in one year, more required three years, and a larger number from three to five years. He makes no mention of unsatisfactory results nor mortality rate.

Speaking of early operation, as advocated by Ely and that which I have suggested, he says, "While these may be of value in certain selected cases, it is doubtful if they are advisable as routine methods."

Very significant are the observations of Chas. F. Painter of Boston.³ Painter asserts that a tuberculous lesion is a constant menace to its possessor long after an apparent cure has been affected. He frankly questions the correctness of diagnosis in certain cases in the statement that many of the best results in cured cases are probably not tuberculosis.

He dwells upon the fact that tubercle bacilli live indefinitely in an encapsulated area, and fears recrudescence after the lapse of a variable interval. He states that during the past eight years 130 cases of "Pott's" and 180 cases of hip-joint disease were treated at the Kearney Hospital Clinic. A very considerable number of these cases came for secondary treatment after an interval of quiescence.

To these Painter applies the term "malignant" (recurring), and endorses the statement of Barker and Croft: that cures reported in orthopædic statistics are wholly unreliable.

³ Trans. of Am. Orthopedic Assn., 1902, "Malignancy of Joint Tuberculosis."

He warns patients who are cured by ordinary methods of the tendency to recurrence and insists that abatement of symptoms is in no sense an assurance against later trouble.

He expresses the opinion "that exploratory interference, with a view to removal of isolated foci in children is often advisable, and is to be urged in a majority of the recrudescences if seen early."

These views regarding the clinical history of bone and joint tuberculosis are fully in accord with my own. Repeated reference by many orthopædic writers to the protracted struggle for quiescence and apparent cure is of extreme interest, and in my opinion suggests to the general surgeon the propriety of assuming jurisdiction in a field uniformly conceded to the orthopædic specialist.

Latency as applied to bone tuberculosis, as to other surgical conditions, is a word to juggle with, and to my mind is little short of a misnomer. There seems to be a close analogy between tuberculous foci and a considerable pathological group, such as gall-bladder disease, chronic appendicitis and renal lithiasis.

No fact is better established than that alleged latency in this latter group is based upon error and is perniciously misleading. That insidiously progressive and harmful changes occur during a period of alleged latency in gall-bladder disease is beyond question.

To leave an accessible tuberculous bone focus, whether isolated or not, to smoulder until provoked to renewed activity at a later period is without justification, and seems to do violence to surgical principles. Certainly such a course in the presence of an osteomyelitis due to ordinary pathogens would be reprehensible. Can it be otherwise than true that thorough removal of the focus and surrounding tissue is as logical for tuberculous as for ordinary osteomyelitis?

Brackett of Boston, editorially in the *Am. Jour. of Orthopædic Surgery*, says, "It is not to be expected that surgery, meaning operative surgery, will replace conservatism, but it is to be hoped that it will shorten the long and disastrous

periods of conservative methods; disastrous because of the almost waste of time in years of disability and the danger accruing to general health."

It is a matter of regret that so eminent an authority did not further elucidate his plan and explain by what technic he hopes to avoid the "almost waste of time" and prevent some of the disastrous consequences of pure conservatism.

It is a fact that resort to operative treatment has rarely been looked upon with favor during that interesting and critical period which goes before extensive invasion and joint destruction. On the contrary, radical treatment has been appealed to after conservatism has failed and when grave complications have rendered desperate measures inevitable.

The propriety of operative interference, with reference to radical cure during incipiency, depends upon two factors: (*a*) Early diagnosis; (*b*) accurate localization of the focus.

The former requirement is fundamental. The clinical history and symptom complex, together with tuberculin reactions and local joint conditions will furnish sufficient data on which to base a tentative opinion. Buxton⁴ says emphatically: "The easier the diagnosis, the worse the prognosis. This applies more aptly to the treatment of this condition than to any other human ailment."

The possibility of lues must be carefully considered, and each case must be studied with reference to the acute conditions due to ordinary pathogens.

Localization in very early cases is a matter of some difficulty and may be impossible. Primarily, we know that in those bones most commonly affected, certain areas are a favorite seat of implantation. Persistent pain and tenderness over a circumscribed area are significant as pointing to the seat of disease. With fair assurance that an accessible focus lies beneath the cortex within reasonable limitations, the operator need not be too precise as to its exact anatomical relations.

* Va. Med. Semi-Monthly, November, 1913.

But final localization in obscure cases must be deferred until the focus can be identified in the radiogram.

I wish to insist that in the acute, fulminating cases delay for any purpose is extremely hazardous, and that to this type, if to no other, early incision and evacuation offers peculiar advantages.

The objects to be obtained by early, direct interference are: (a) Permanent cure by elimination of the focus; (b) reduction of time of treatment from years to months; (c) prevention of complications, such as abscess formation, mixed infection, disintegration of bone and joint structures, crippling deformity and loss of function; (d) avoidance of systemic invasion and loss of life.

Operative technic is usually simple. Every exaction in the interest of asepticity must be observed. The most available extra-articular route is to be chosen. A rather liberal incision is carried to and through the periosteum. A sufficient area of bone is exposed over the suspected part. With a trephine or chisel the cortex is removed until the opening affords easy access to the marrow. With a strong, sharp curette the end of the bone is converted into a shell-like cavity, whose dimensions must depend upon the judgment and tactile sense of the operator.

The propriety of interfering with the epiphyseal cartilage has been questioned, particularly in the very young. My opinion is that if the disease has extended from its original location across this cartilage not much respect need be paid to it; if in the remote side it will naturally be preserved. Utmost care must be exercised to avoid perforation of the cortex so as to communicate with the synovial cavity.

The resulting chamber may be dealt with variously.

Sherman of San Francisco, after a liberal application of pure carbolic acid and alcohol, fills the cavity with normal salt solution, and closes the wound in tiers. In a series of uncomplicated cases, he has not had a failure and he commends the method strongly.

I have generally depended upon camphor phenol gauze

packing (phenol one part, gum camphor three parts). The gauze is wrung dry and closely packed into the cavity. A few days later the amount of gauze is lessened and a little later is discarded. Such wounds heal rapidly and all discharge ceases in less than a fortnight under an aseptic dressing.

The great value of camphor phenol as an antiseptic is in the presence of infections, and as a safeguard in clean, open wounds seems not to be generally understood.

After removal of the initial dressing the cavity is usually free from blood, and can be filled with Beck's paste or the Mosetig-Moorhof wax. The wound may then be closed in the usual manner and fixation secured by a rather loosely applied plaster-of-Paris dressing.

I am able to report sixteen cases in which I have pursued the plan herein described, as follows: upper end of femur, three; lower end of femur, five; upper end of tibia, four; internal malleolus, two; lower end of radius, two.

In three of the operations upon the condyles of the femur, wound infection was encountered and convalescence delayed. In no case was the end result unsatisfactory, either from the stand-point of serious loss of function or of recrudescence. The mixed infections were encountered during my earlier experiences, when technic was far from perfect. The history of these cases is in marked contrast to manifold experiences had in late suppurating conditions.

I have been deeply impressed throughout with the fact that the sooner operative treatment was undertaken after diagnosis and localization, the simpler was the procedure, the shorter the time of convalescence and less was the degree of loss of function.

Attention is especially called to the three hip-joint cases noted above, in which my interest has centred, and which are already in the literature.⁵

Following the suggestion of Macnamara,⁶ I proceeded to

⁵ Am. Jour. Med. Sciences, July, 1905; Surgery, Gynecology and Obstetrics, April, 1906; Surgery, Gynecology and Obstetrics, October, 1911.

⁶ Disease of Bones and Joints, 1881.

tunnel into the neck of the femur, through a trephine opening below the great trochanter, thereby removing most of the soft content of the neck. In one instance it was necessary to repeat the operation after a lapse of two weeks. At this time the epiphyseal cartilage was perforated, though but a small part of the head of the bone was removed.

The diagnosis in the three cases which constitute my series has been sharply questioned.

Heredity in every instance pointed to tuberculosis, and in one (a fulminating case) the patient suffered from a tuberculous lesion in the apex. The clinical history was most convincing. These patients are accessible and have been closely observed. All were well without recrudescence after a lapse of eleven, ten and eight years respectively. The average time of treatment about six months. One patient left the hospital in one month and was reported well in two months.

The functional results are as follows: One has nearly one inch shortening with motion through an angle of 35 degrees. This patient left my care permanently at the end of one month. It is fair to assume that the loss of joint function could have been measurably lessened by careful attention subsequent to the operation.

The second case has one-half inch shortening with nearly perfect function.

The third case has neither shortening nor loss of function.

Henning Waldenstrom of Stockholm,⁷ with a large experience, is an ardent advocate of extracapsular removal of the focus. He has devised what he calls "a prophylactic operation." With a slightly different technic he accomplishes a purpose similar to my own.

Sherman's experience in this field leads him to justify the method, but he insists that a focus must be localized within narrow limitations before attempting relief. In at least four cases he has succeeded admirably.

⁷ Monograph: "Tuberculosis of the Hip in Children," 1910.

FRONTAL SINUS SUPPURATION.*

THE ESTABLISHMENT OF PERMANENT NASAL DRAINAGE; THE CLOSURE OF EXTERNAL FISTULÆ; EPIDERMIZATION OF SINUS.

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THE logical treatment of most pathologic conditions is based upon an understanding of the cause. The condition with which we have to deal is that of chronic suppuration in a natural bony cavity which has a single small opening. We have to contend with changes produced by bacterial action and by mechanical obstruction.

PATHOLOGY.—1. *Acute catarrhal inflammation:* Following an attack of acute coryza, it is very common to observe an acute inflammation in the accessory sinuses, of which the frontal sinus is no exception. Its course is generally moderate and it is followed by complete resolution. If the ostium becomes occluded, an abscess or acute empyema may follow. This complication is more serious and the pus must escape sooner or later. This may be relieved by surgical intervention, or some wall of the sinus may ulcerate through, or relief may be spontaneous through the natural opening. Chronic suppuration is not an uncommon sequence.

2. *Chronic catarrhal inflammation:* This is a comparatively common condition, manifested clinically by the presence of pus in the middle meatus, together with certain subjective, and sometimes other objective, signs which it is not the aim of this paper to consider. The pathologic changes are of great importance. The mucous membrane of the sinus undergoes the changes common to any mucous membrane which is the seat of a chronic inflammation. It becomes thickened from œdema and connective tissue proliferation, the surface is irregular and sometimes ulcerating, and there may be polypoid growths sufficient to fill and cause pressure within the sinus.

* Read before the American Surgical Association, April, 1914.

The ciliated epithelium is often destroyed. The ostium is more or less obstructed so as to impair drainage permanently. In some instances the periosteum and bone may be involved but such is the exceptional result.

The subsequent course will depend upon the degree and length of time of the obstruction and also upon the nature of the secondary changes in the mucous membrane.

TREATMENT.—The problem of the treatment of suppuration in any cavity depends upon the nature of the anatomic and pathologic conditions. Let us consider the general underlying principles which govern the treatment of suppuration in the various kinds of cavities.

1. *In Soft Tissues.*—If pus is evacuated from an abscess or cellulitis and efficient drainage is provided, the abscess wall collapses, the cavity becomes smaller and gradually closes from the bottom and, in a comparatively short time, the parts are healed. The closing progresses from the depths to the surface. This is what happens even in the closing of suppurating cavities within the abdomen, and we all know to our discomfort what it means to have the opening in the abdominal wall close before the deeper parts of the suppurating cavity are practically obliterated.

2. *Suppuration in Cavities with Partially Rigid Walls.*—Suppuration in the pleural cavity—empyema—is a type. The cavity is made by the pus crowding the lung. In the cases operated upon early with the establishment of suitable drainage, maintained continuously until the lung gradually expands and thus obliterates the cavity, a cure is obtained.

In the chronic cases excessive adhesions and connective tissue formation tend to prevent lung expansion. Such cases may fail to heal, although the drainage be ample, because a large cavity with suppurating walls persists. In rare cases, under such conditions, relief may be afforded by decortication or better by causing the rigid and almost unyielding chest wall to sink in to meet the lung and thus obliterate the cavity. This is accomplished by extensive rib excision. Hence, suppuration in the pleural cavity will persist until the cavity is obliterated.

erated by one means or another but, if not obliterated, the subsequent course will depend upon the facility with which it drains. If the opening becomes occluded too early, acute symptoms follow; if it remains patent, the discharge continues indefinitely, varying in amount more or less according to the size of the cavity and the freedom of drainage.

3. *Suppuration in Bony Cavities with Entirely Rigid Walls.*

—(a) Unnatural cavities, for example, in osteomyelitis of long bones. Relief is obtained only after sequestra have been removed and the cavity obliterated by granulation tissue—healing from the bottom. In the shaft of long bones the healing may take place without much subsequent scar or bony defect, but at an enlarged extremity, as, for example, the upper end of the tibia, the extensive loss of cancellated structure may leave only the cortex as a rigid wall of a chronic suppurating cavity. Destruction of this cortex, in order to obliterate such a cavity, would mean a fractured leg, which of course would be an unjustifiable procedure. Some cavities of this sort never heal, some become epidermized after a very long period, leaving a more or less deep depression, and, in rare cases, a cavity may be obliterated by some sort of graft. Much of the cell structure of the mastoid, when inflamed, presents the same situation. In all the above examples of suppurating cavities, healing takes place only by obliteration of the cavity.

(b) *Suppuration in natural bony cavities.* Such cavities occur only in the head; they are lined with mucous membrane and communicate externally through the ear or nose. Frequently, they are the site of chronic inflammation. Relief may be obtained by efficient drainage, resulting in complete resolution, or by obliteration of the cavity, or, in a measure, by a combination of these methods, in cases where it is either unwise or impossible to entirely obliterate the cavity.

The frontal sinus is a natural cavity with rigid bony walls and the problem of treatment of suppuration depends upon anatomic and pathologic conditions. The chances of cure and differences in cosmetic effects vary according to the mode of treatment.

Let us now consider some of the methods used for the treatment of these cases.

Acute Catarrhal Inflammation of the Frontal Sinus.—This paper concerns chiefly the treatment of the more obstinate cases of chronic suppuration. In passing, however, let it be said that various degrees of acute inflammation are very common, but most of these resolve spontaneously in the course of a few days without particular treatment. Very occasionally, comparatively speaking, the ostium becomes occluded and abscess with perforating of a sinus wall results, but very often, after repeated exacerbations, the process becomes chronic and some sort of surgical interference is necessary.

Let us review briefly the principles underlying the chief operative measures for the relief of chronic frontal sinus suppuration. These may be classified as (1) intranasal operations and (2) extranasal operations.

(1) *Intranasal Operations.*—Certain anatomic features will be discussed in detail later, but, suffice it to say here, that the sinus drains through a comparatively small opening in its floor in close proximity to several anterior ethmoid cells and the extreme upper front portion of the middle turbinate bone. Attempts to cure all chronic cases should be made first by intranasal methods. These consist in the removal of the anterior portion of the middle turbinate and the breaking up of as many anterior cells as possible, the object being to establish free drainage. Many patients obtain satisfactory relief by this means. Attempts may be made to probe the sinus but there is always some doubt as to the success of such attempts, for reasons so frequently recorded by anatomists and clinicians. More radical intranasal methods are recommended and practised by some. These include the operations which aim to enlarge the frontal opening by means of burr drills and different types of raspatories, aided by the use of shields of different shapes and other guides to prevent injury to the bone posterior to the ostium. It is possible to probe some sinuses and then to enlarge the bony opening by these methods and obtain beneficial results. On the other hand, it is perfectly

obvious in the greater number of cases that the probe is not positively in the sinus and that the operator has absolutely no means of knowing the bony relations and, therefore, can never be reasonably sure of just what he is doing. The distances around the ostium are so short, the portions of bone to be removed so thick, and the bone protecting the dangerous structures so thin, that I am firmly convinced that what amounts to "blind operating" is unwise, particularly when there are other methods which allow of a certain amount of vision. These more radical intranasal methods involve far greater risk to life, for reasons so often detailed by others, than the external operations in which we are better able to see just what is being done. Furthermore, I believe that all very radical operations for the cure of chronic suppuration are serious and should not be looked upon lightly. The parts are so small and the importance of removing all bone around the ostium so great, that I believe it can be accomplished only by the aid of vision, which ensures both precision and safety. Hence, to summarize, I would say that, primarily, in all cases the front of the middle turbinate and all cells and growths in the vicinity lying below the ostium should be carefully removed and then some weeks allowed to elapse in the hope that a satisfactory cure will follow. Although I think that the complete removal of the nasal floor of the sinus is the essential factor in the cure of these cases, I believe that the nasal route is inefficient and unnecessarily dangerous even in skilled hands.

(2) *Extranasal Operations.*—The object of all operations is to cure the condition. There are two general types of extranasal methods; one aims to enlarge the natural opening and the other is a destructive method which aims to obliterate the sinus. Some methods tend to combine these principles. It seems to me that most of the very radical methods simply offer different degrees of exposure of the sinus, and, if the sinus is one that cannot be obliterated, a cure does not follow because the essential cause is not removed. In other words, the removal of large portions of the facial and orbital walls does not affect the size of the region of the ostium where the

opportunity for enlargement is none too good at best. However, this general removal of surfaces does do good and in many cases is followed by satisfactory healing because the sinus is practically obliterated or made so small that it is no longer troublesome, but the cosmetic results are unsatisfactory.

(a) *Operations to reestablish drainage:* The Ogston-Luc operation, described by the former in 1884 and modified by the latter in 1894, is essentially a curetting of the cells around and below the ostium, chiefly through an opening in the facial wall. Modifications consist in the use or not of different types of temporary nasal or external drainage, but, finally, events must be left to take a natural course. Relief might follow but failures have been so common that more radical measures were adopted. Failure was, of course, due to recurrence of obstruction at the ostium, sometimes followed by an external fistula. Although the Ogston-Luc operation has been given up largely for the more destructive methods, its conception was in the right direction so far as combining a cure and good cosmetic results is concerned.

In this group we have also various osteoplastic resections combined with curetting around the ostium, one of which the writer devised and published in 1898. I believe these are unwise because it is not good technic to attempt plastic bone surgery around such suppurating cavities. The risk of spreading infection is great, the flap of bone is prone to necrosis because of the lack of nutrition, and its loss is followed by unnecessary deformity.

(b) *Efforts to obliterate the sinus:* Most of these operations combine a certain amount of curetting of ethmoid cells with that of the whole sinus; some do not disturb the floor of the sinus.

In 1894, Kunt suggested the removal of the facial wall so as to allow the skin to come in contact with the cerebral wall of the sinus; this would fail to obliterate a deep sinus.

Jansen's plan, formulated in 1893, was to remove the orbital floor; this would not obliterate a high sinus.

In 1898, Riedel resected both facial and orbital walls; this

was more likely to obliterate the sinus, but the deformity is very marked.

In these attempts at obliteration, obstinate and troublesome pockets of pus persist in distal portions of large sinuses, so that suppuration and fistulæ continue.

In 1902, Killian suggested the resection of the orbital and facial walls, including a considerable portion of the nasal process of the superior maxilla, but left a bridge of bone along the supra-orbital arch so as to lessen the subsequent deformity. He includes also a thorough curetting of the neighboring cells and removal of a portion of the nasal crest of the frontal bone.

These four methods represent the general types of obliterative operations and various modifications of each have been devised. The Killian is the most radical and probably gives the greater percentage of cures. Failures are not uncommon and even here eventual deformity and occasional sequelæ persist. In the Killian method, if the sinus cannot be obliterated, the avenue of escape of exudate into the nose is narrowed because the soft parts fall in and are drawn in by scar tissue at the level of the site of the ostium because the support given by the upper portions of the nasal process and lachrymal bones is gone. Although one sees it stated frequently that the Killian operation is the final word in frontal sinus operations, still the results demonstrate that there is much more to be desired.

Some General Considerations.—The essential cause of continued frontal sinus suppuration is inadequate drainage which, in turn, may be followed by aggravating complications. Relief may be obtained by obliterating the sinus, or by establishing adequate drainage. The former cannot always be accomplished and it invariably results in objectionable deformity. On the other hand, it is not easy to obtain the desired amount of drainage. We must decide in each case, considering all the evidence at hand, whether we shall endeavor to obliterate the sinus or provide adequate drainage. The larger the sinus, the more difficult will be the task of obliterating it, and the more objectionable will be the deformity. On the other hand, the larger sinus is more easily drained and open to subsequent in-

transnasal treatment, which is required after most sinus operations. If we can obtain a cure without bony deformity, this of course is desirable. In a general way, the larger the sinus the more trouble it causes, because of its increased area for suppuration and its greater capacity for granulations and polypi. The technic to be described seems to me to be particularly indicated when the sinus is large, when both sinuses are affected, or when an external fistula is present, and it should afford relief also after other methods have failed. The method avoids injury to the orbital contents, such as result in cellulitis, double vision, and inflammation of the lachrymal sac. It ensures easy access for the subsequent treatment of granulations, while the distal narrow angles and borders tend to become obliterated by scar tissue and the size of the new ostium, which can readily be kept open, prevents the retention of exudate until, finally, the remaining walls of the sinus cease to give rise to exudate and become covered with smooth scar tissue or mucous membrane. The ostium can be made actually as large as the anatomy will allow while the natural bony outline is preserved. If we are striving to get drainage, then I believe that the principle of the Killian and such operations is at fault, because, by the removal of the upper portion of the lachrymal bone, the nasal process, and the immediate adjacent part of the frontal bone, we take away bony support just where we need it and thereby allow the soft parts to fall in and be drawn in by contraction at a point where every fraction of an inch is most valuable.

The various external operations differ chiefly in the method of approach to the sinus, but the real issue is that of efficient drainage.

Hence, if the intranasal efforts for drainage described above fail, I believe we should attempt to establish it by the use of a method which is a combination of both the internal and external routes.

ANATOMY.—In considering the anatomy of the frontal sinus, the description will be limited to the structure and topography of those portions which are of practical importance

in carrying out the technic of operation to be described later. Some years ago the writer published in detail the descriptive anatomy of this sinus and the anterior ethmoid cells (see Frontal Sinus and also Turbinate articles), but the following features are more particularly of operative importance.

All of the sinus is in the frontal bone. The sinuses vary in shape and size but, in a general way, present three surfaces and a base. The inner portion of the base and the posterior angle are situated above the extreme anterior portion of the nasal cavity and some of the anterior ethmoid cells (Figs. 9 and 17). The *posterior* or cerebral wall is in front of the frontal lobe of the brain and, although comparatively thin, the bone is dense in structure and not easily injured. This wall should be carefully avoided. The *anterior* or facial wall is the thickest, is more or less cancellated, and is the avenue of approach in most of the so-called external operations. Its extent, thickness and outline vary according to the size and shape of the sinus. The usual exploratory opening is made a little above the extremity of the nasal process of the superior maxilla (Figs. 1, 2 and 19), because the smallest sinus occupies this position. Very thick bone at this point is an indication that the sinus must be very small and does not rise to this level. For practical purposes such a sinus amounts to no more than an ethmoid cell and, of itself, could not be of much pathologic importance.

The *floor of the sinus* is of the greatest surgical importance and consists of an outer or orbital portion, and an inner or nasal portion (Figs. 1, 7, 8 and 11). The orbital portion is comparatively thin but dense. It has an attachment below for the pulley of the external oblique muscle, the dislodgment of which is undesirable. The more or less complete removal of the facial and this portion of the floor of the sinus is carried out in some operations directed toward the obliteration of the sinus, resulting in deformity according to the size of the sinus and the method adopted. The size and shape of some sinuses preclude obliteration.

The nasal portion contains the single ostium (Figs. 15 and

17) leading to the nose, and is made up of both very thin and very thick areas of bone. It is bounded externally by the suture between the lachrymal and frontal bones and somewhat by the suture between the nasal process and the frontal bone (Figs. 1, 7, 8 and 17). Internally it is bounded by the interfrontal septum, which is the upward projection of the plane of the nasal septum, although it may not necessarily be in the median line (Figs. 5, 11, 13 and 17). In front the boundary lies roughly behind the upper border of the nasal bone and the nasal process of the superior maxilla (Figs. 8 and 9). Although these bones do not form part of the wall of the sinus, they bear an important surgical relation to its floor. Posteriorly, the floor of the nasal portion comes to an angle made by three surfaces—floor of sinus, cerebral surface, and interfrontal septum (Figs. 4, 8 and 17). Toward this angle is situated the ostium. The floor in the vicinity of the ostium is made up of thin bone which forms the walls of some of the anterior ethmoid cells. External to the ostium are the cells, completed by the lachrymal bone. Posteriorly one meets oftentimes an ethmoid cell protruding into the sinus called the frontal bulla, and behind this are other anterior and then the posterior ethmoid cells (Figs. 9, 10, 11, 15 and 18). In front of the ostium one is apt to meet an anterior cell and still further in front is the so-called nasal crest of frontal bone (Figs. 7 and 8), and still in front are the thick and dense upper ends of the nasal bone and nasal process of the superior maxilla (Figs. 12 and 13). Internal to the ostium and below it are thin lamellæ of bone subject to some immaterial variation, according to whether the ostium leads to the infundibulum or still further internal, so as to open under the forward projection of the middle turbinate bone (Figs. 8 and 15). In all instances the frontal sinus can be said to open into the nasal cavity through the anterior upper portion of the ethmoid bone (Figs. 9, 15 and 18).

Hence the ostium is surrounded on all sides by thin bone which may be fractured with comparative ease and thus a larger opening made. If this thin bone is broken away, and

this is usually what is accomplished by the majority of operators, what seems to be a reasonably large opening to the sinus is obtained. This may suffice for the cure of many cases, but many failures follow because the opening becomes obstructed later.

If the under surface of a disarticulated frontal bone be observed (Fig. 7), the opening into the sinus will be found to correspond to the enlarged opening just described by breaking the walls of anterior ethmoid cells. It is commonly stated that this is the full extent of enlargement that the anatomy will allow, although some include the thin portion of the nasal crest of the frontal bone in this removal. Nevertheless, an opening in many instances nearly as large again may be obtained by removing a portion of the frontal bone which articulates with the nasal bone and nasal portion of the maxilla, together with the adjacent thick portion of these two bones (Figs. 8 and 13). This will be considered further later on. Internal and posterior to the ostium is a dangerous region which, as a rule, should be carefully avoided because of the risk of breaking into the cranial cavity (Figs. 9 and 17). The ostium is about on a level with the cribriform plate and the slit for the nasal nerve is internal and rather close to it, hence the great importance of the early introduction of a probe through the ostium which should be left there as a guide during the early part of the operation.

If a frontal bone be disarticulated, the following features will be observed in the region of the floor of the sinus around the bony opening, now comparatively large because the ethmoid cells are removed (Fig. 7). Externally is seen the line of articulation with the lachrymal bone and posteriorly the ethmoid cells. Posteriorly and internally is found the front end of the cribriform plate (Fig. 8), in front of which is a comparatively thin horizontal portion of the frontal bone called the nasal crest. This forms the inner boundary of the ostium. In front of the ostium, extending forward and toward the median line, is a dense and thick portion of bone of considerable area where the nasal process and the nasal bones

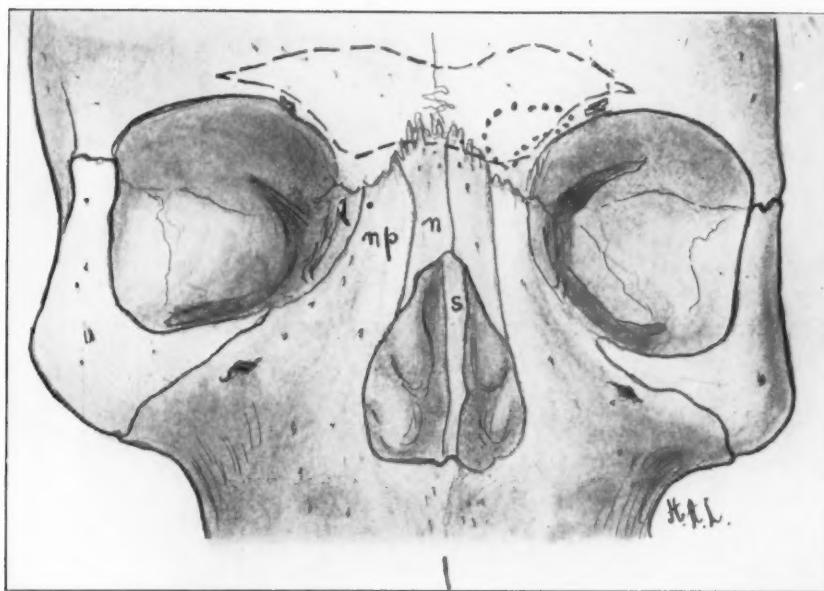
articulate (Figs. 3, 4, 5, 8 and 13). This is a portion of the floor of the sinus which is not fully made use of in sinus operations.

In the median line, still a part of the floor, particularly if we consider the two sinuses together, we observe the thickened portion of the frontal bone where the perpendicular plate of the ethmoid bone articulates and, in front of this, the spine of the frontal bone (Figs. 5 and 14). In Figs. 3 and 4 we note the extreme upward and forward prolongation of the middle turbinate bone, external to which are the infundibulum and ethmoid cells, subject to comparatively immaterial individual variations as to ostia and cells. Internal to this lamella of the turbinate is the extreme anterior end of the roof of the nasal fossa formed in part behind by the cribriform plate (Fig. 8).

If, on the other hand, we look down upon the section after the frontal bone has been removed (Figs. 9 and 10), we observe again the structures around the bony opening from the sinus. The lachrymal bone and groove for the lachrymal sac are to be seen externally and behind are the ethmoid cells and cribriform plate; internally is the perpendicular plate and in front are the thick upper extremities of the nasal bones and the nasal processes of the superior maxillæ. Hence these two views (Figs. 9 and 10) demonstrate why a probe is left in the ostium during the early stages of the operation to serve as a guide to enable us to avoid destruction of bone posterior and internal to the ostium. These views indicate also the bone which may be removed in front and external to it.

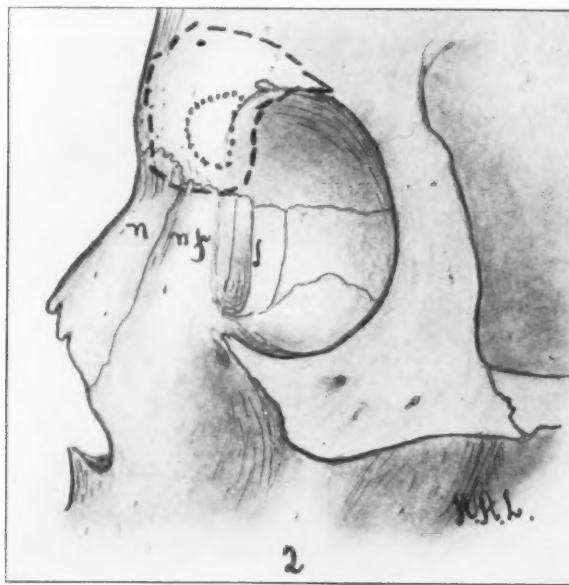
The distance between the front end of the cribriform plate and the upper ends of the nasal bones (Figs. 7, 8, 10, 17 and 21) is also subject to variation, and the knowledge of this distance before operation is of great importance. This can be determined by X-ray examination (Figs. 21-26). A lateral view of this region will add to an understanding of its topography (Figs. 4, 5, 10 and 21-26). Near the median line (Figs. 4 and 5) the thinner portion of the sinus floor shows posteriorly, and in front it becomes very thick and dense, made up

FIG. 1.



Front view skull. Projected outline of frontal sinus and opening into it. *n*, nasal bone; *np*, nasal process of superior maxilla; *s*, septum of nose; *l*, lachrymal bone.

FIG. 2.



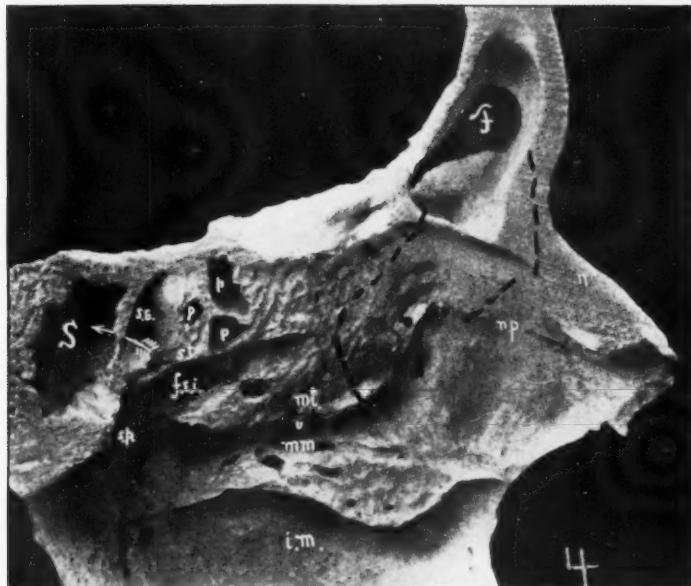
Side view showing projected outline of sinus and opening into it. *n*, nasal bone; *np*, nasal process; *l*, lachrymal bone with groove for sac and duct.

FIG. 3.



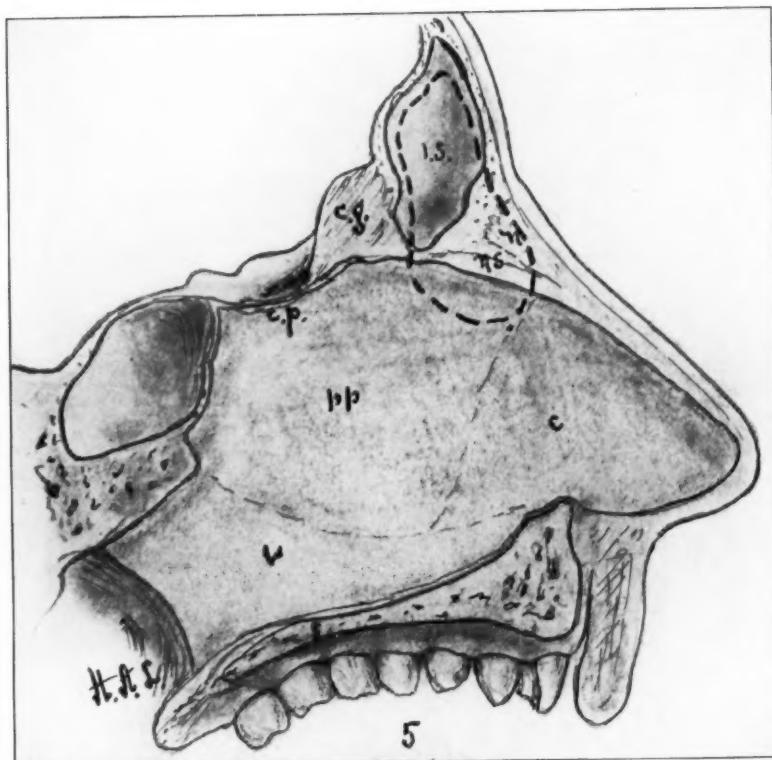
Outer bony wall of right nasal fossa. *F*, frontal sinus; *S*, sphenoidal sinus; *s.p.*, sphenopalatine foramen; *f.e.i.*, inferior ethmoidal fissure, arrow enters a posterior ethmoid cell from a middle ethmoid fissure; *a*, an anterior ethmoid cell which makes a frontal bulla; *n*, nasal bone; *n.s.*, nasal spine of frontal bone; *n.p.*, nasal process of superior maxilla; *m.t.*, middle turbinate bone; *m.m.*, middle meatus; *u*, uncinate process; *i.t.*, inferior turbinate; *i.m.*, inferior meatus. Dotted line shows the portion of bone to be removed.

FIG. 4.



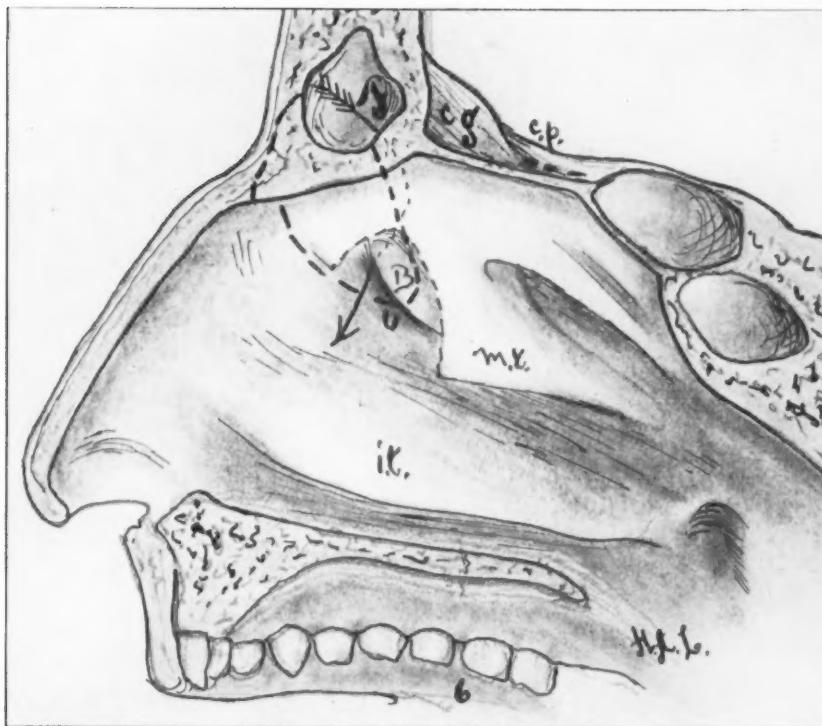
Outer bony wall of left nasal fossa. *F*, frontal sinus; *S*, sphenoidal sinus into which an arrow points passing through the ostium sphenoidale; *n*, nasal bone; *np*, nasal process of superior maxilla; *p.p.*, broken posterior ethmoid cells; *s.t.*, superior turbinate; *f.e.i.*, fissura ethmoidalis inferior; *s.p.*, sphenopalatine foramen; *m.t.*, middle turbinate; *u*, uncinate process; *mm*, middle meatus; *i.m.*, inferior meatus; *i.t.*, inferior turbinate. Dotted line shows the portion of bone to be removed.

FIG. 5.



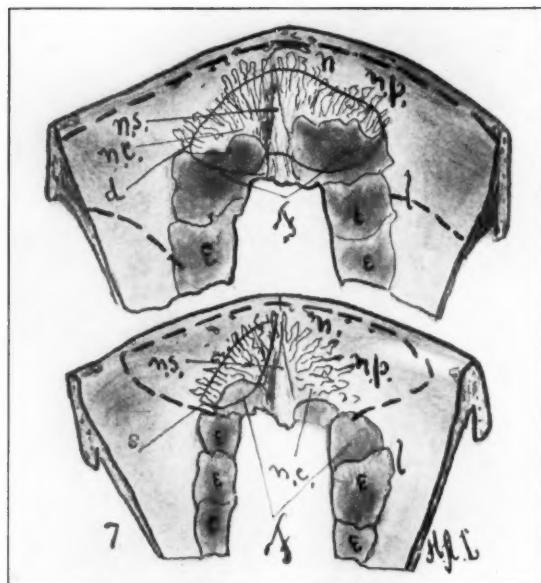
Shows interfrontal and nasal septum. *n*, nasal bone; *ns*, nasal spine of frontal bone; *c.g.*, crista galli; *c.p.*, cribriform plate; *pp*, perpendicular plate; *v*, vomer; *c*, triangular cartilage. Dotted line shows the portion to be removed in operations on both sinuses.

FIG. 6.



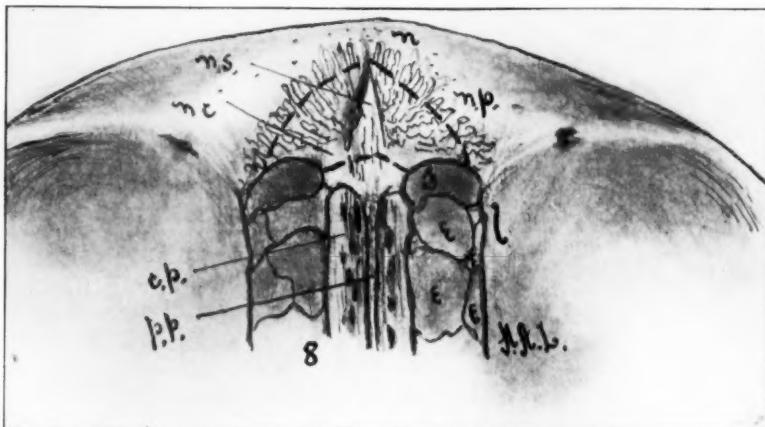
F, frontal sinus; arrow passes through its ostium coming out through the infundibulum at the hiatus semilunaris; *cg*, crista galli; *c.p.*, cribriform plate; *m.t.*, middle turbinate; *i.t.*, inferior turbinate; *B*, ethmoid bulla; *u*, unciform process. Dotted line shows the bone to be removed whether for single or double sinus.

FIG. 7.



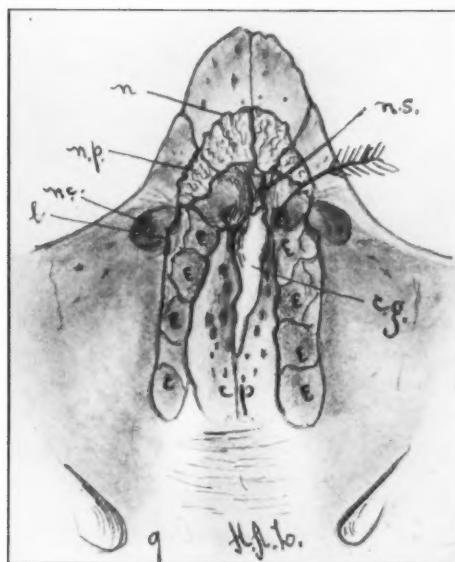
Portions of frontal bones, under surface. *F*, opening to frontal sinus; *n*, for articulation with nasal bone; *n.p.*, with nasal process; *l*, with lachrymal bone; *e*, for completion of ethmoid cells; *n.s.*, nasal spine; *n.c.*, nasal crest; *s*, thick bone to be removed for a single sinus; *d*, for a double sinus.

FIG. 8.



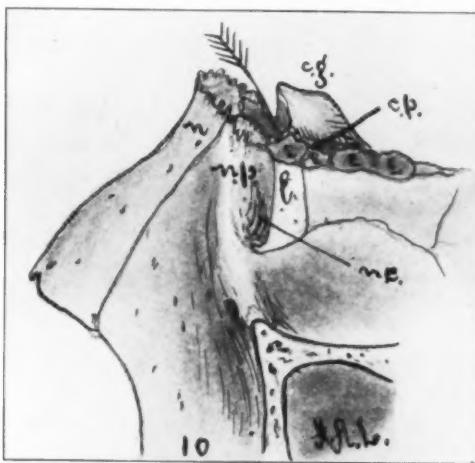
Under surface of frontal bone with cribriform and perpendicular plates. *F*, natural bony opening into frontal sinus; *n*, for articulation with nasal bone; *n.p.*, with nasal process; *l*, with lachrymal bone; *n.s.*, nasal spine; *n.c.*, nasal crest. Dotted line shows the extent of bone to be removed in operating on both sinuses.

FIG. 9.



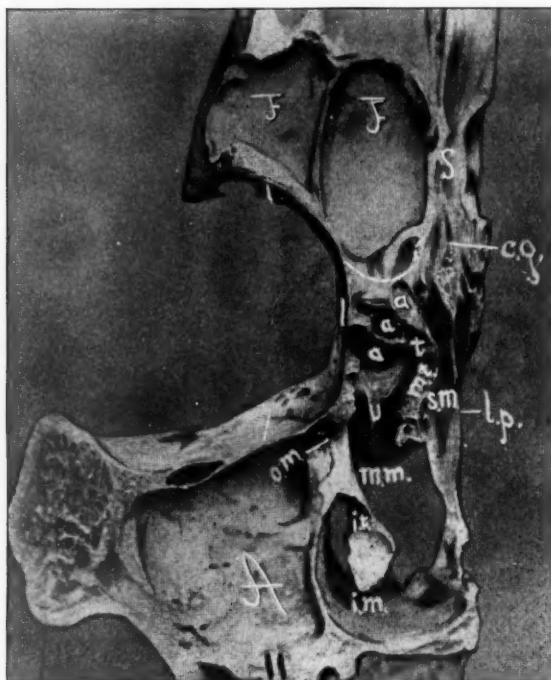
Showing structures under frontal bone. *n*, nasal bone; *n.p.*, nasal process; *l*, lachryma bone; *n.c.*, nasal canal; *c.g.*, crista galli; *c.p.*, cribriform plate; *e*, ethmoid cells. Arrow through ostium of right frontal sinus.

FIG. 10.



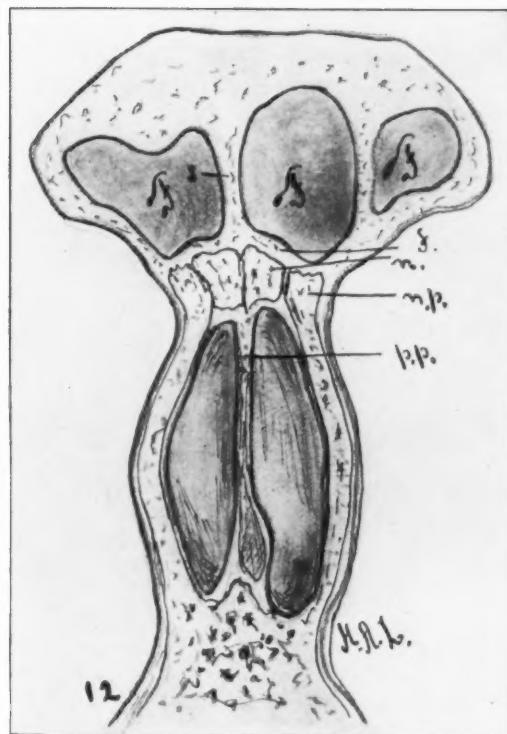
Side view of Fig. 9. Same lettering.

FIG. II.



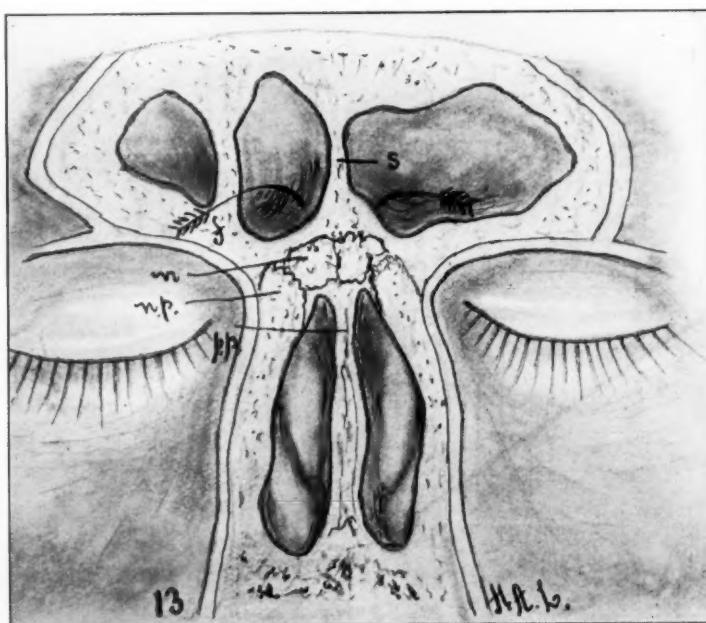
Bone. Coronal section through ostium maxillare; anterior half. Posterior wall of frontal sinus removed. *F*, an anterior wall of frontal sinus showing a vertical septum; *S*, septum between the frontal sinuses; *i.t.*, inferior turbinate; *m.t.*, middle turbinate; *o.m.*, ostium maxillare; *u*, uncinate process; *l*, os lacrymale; *t*, turbinate fossa; *a.a.a*, anterior ethmoidal cells internal to lacrymal bone; *A*, antrum of Highmore; *l.p.*, lamina perpendicularis; *c.g.*, crista galli; *i.m.*, inferior meatus; *m.m.*, middle meatus; *s.m.*, superior meatus; *i*, inferior wall of frontal sinus (orbital portion). Dotted line corresponds to nasal portion.

FIG. 12.



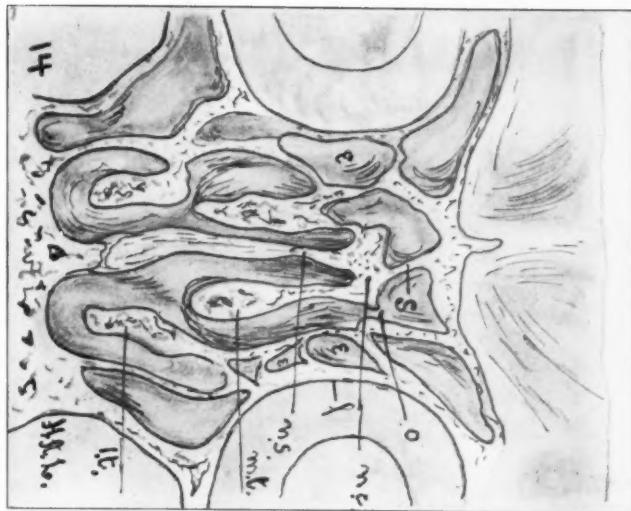
Sagittal section at base of nasal bones, looking forward. *F*, frontal sinuses with a partition in the right side; *f.*, frontal bone; *n.*, nasal bone; *n.p.*, nasal process; *p.p.*, perpendicular plate of ethmoid; *s.*, interfrontal septum.

FIG. 13.



Same as Fig. 12, looking backward, same lettering. Arrows directed toward posterior angles to frontal ostia.

FIG. 14.



Section of same specimen through region of ostia of frontal sinus—first looking forward and then backward, same lettering. *S.*, interfrontal septum; *ms.*, nasal septum; *o.*, ostium frontale; *nc.*, nasal crest; *mt.*, middle turbinate; *E.*, ethmoid cells; *l.*, lachrymal bone.

FIG. 15.

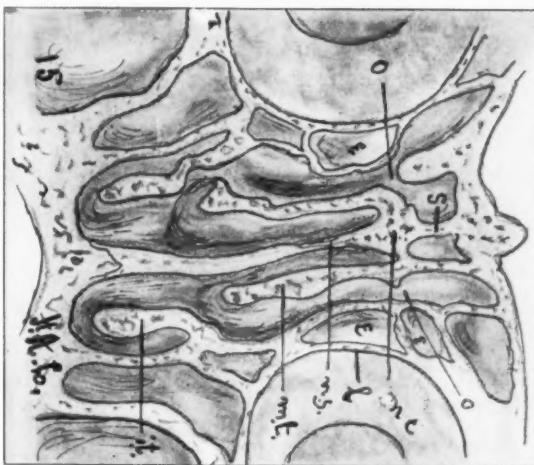
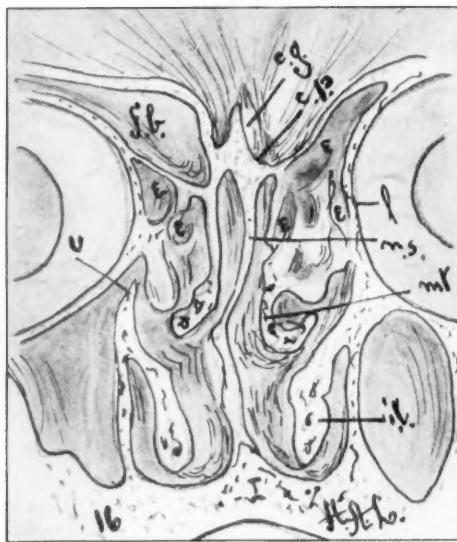
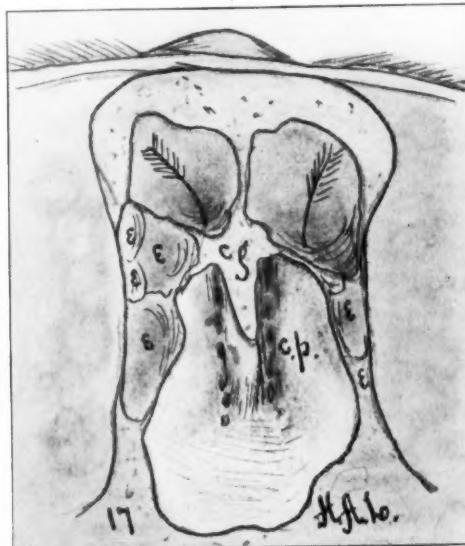


FIG. 16.



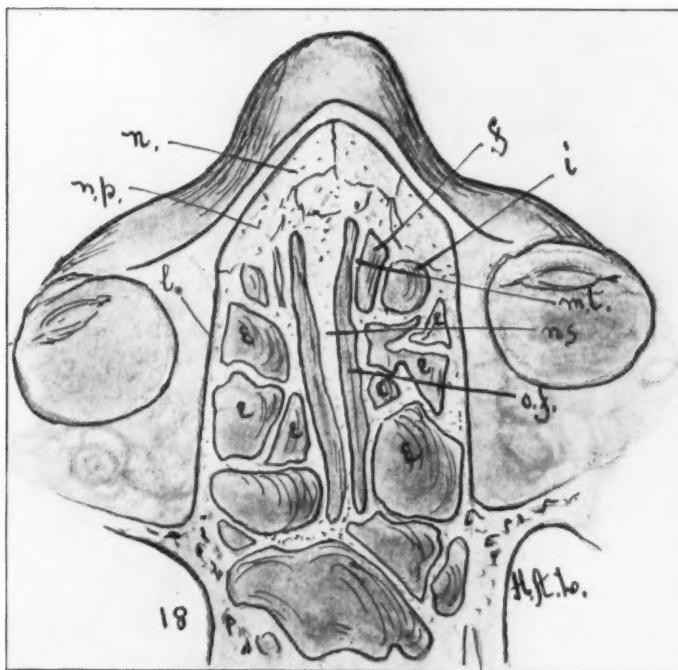
Same specimen, section behind crista galli and ostia of frontal sinus, looking forward.
c.g., crista galli; c.p., cribriform plate; n.s., nasal septum; f.b., frontal bulla; e., ethmoid cells;
l., lachrymal bone; m.t., middle turbinate; l.t., lower turbinate; u., unciform process.

FIG. 17.



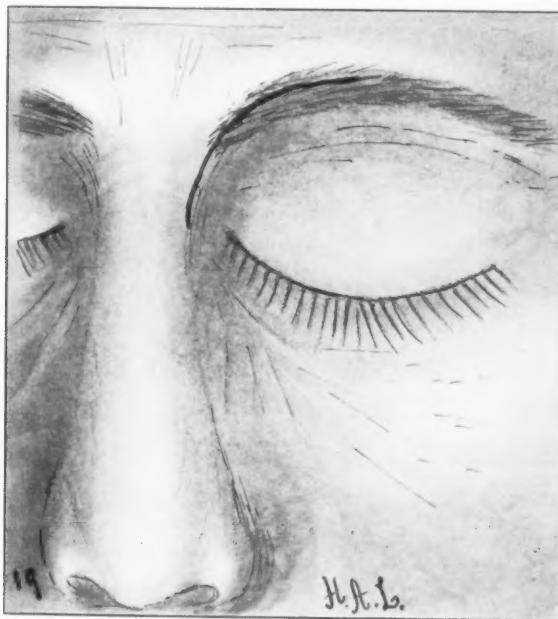
Horizontal section just above level of cribriform plate (c.p.); c.g., crista galli. Arrows in
frontal sinuses directed toward ostium. e., ethmoid cells.

FIG. 18.



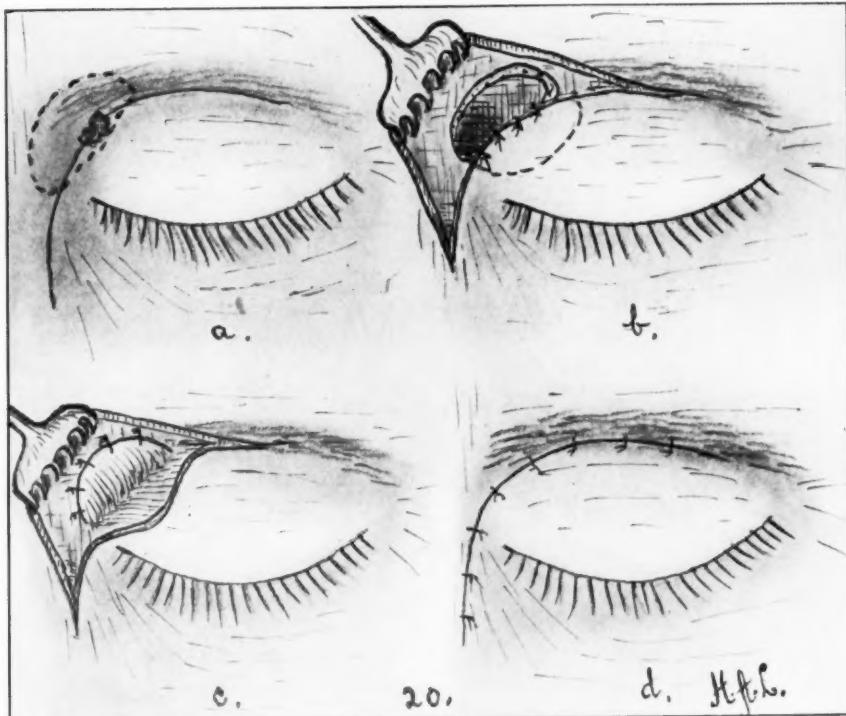
Horizontal section of same specimen just below level of cribriform plate. *n.*, nasal bone; *n.p.*, nasal process; *l.*, lachrymal bone; *ns.*, nasal septum; *m.t.*, upward continuation of middle turbinate; *o.f.*, olfactory fissure; *f.*, leading to frontal sinus; *i.*, infundibulum; *e.*, ethmoid cells.

FIG. 19.



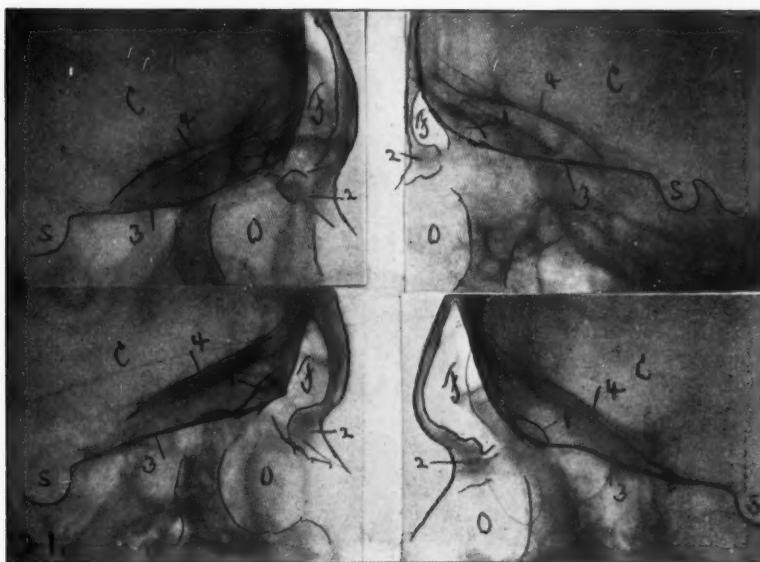
Showing skin incision.

FIG. 20.



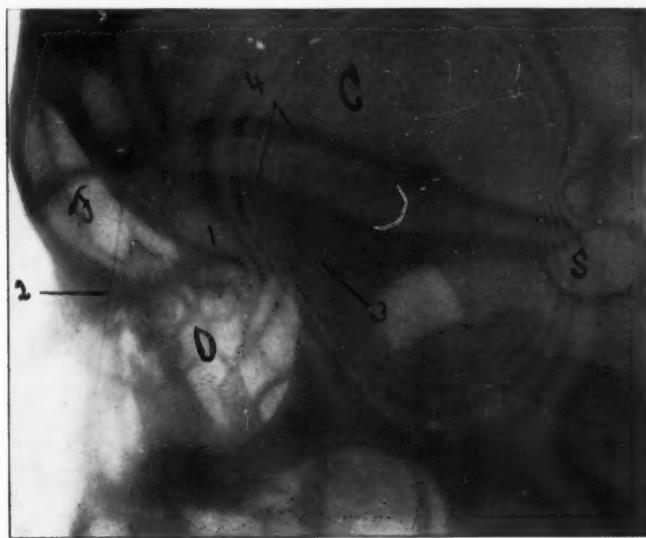
Epidermization of frontal sinus. *a.*, shows scar, fistula and opening in bone; *b.*, bone exposed, edge of lid sutured, outline of skin flap; *c.*, flap sutured in place over opening to sinus; *d.*, wound closed.

FIG. 21.



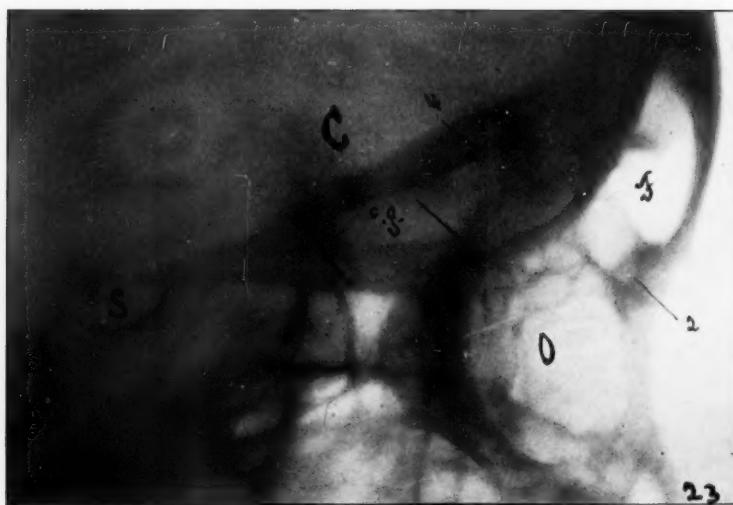
Tracings over lateral skiagraphs to show the dense bone at floor of frontal sinus in front and the relative distance between the base of the nose and the crista galli, most of which can be utilized. 1, crista galli; 2, dense bone made up of nasal and frontal bones and nasal process of superior maxilla; 3, cribriform plate continuing forward in the general curve of the cranial cavity; 4, roof of orbit; F, frontal sinus; O, orbit; C, cranial cavity; S, sella turcica.

FIG. 22.



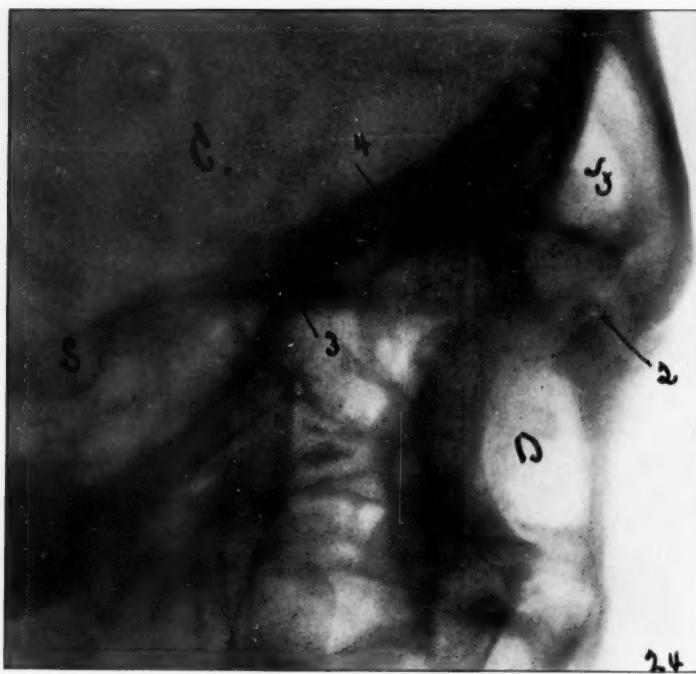
Lateral skiagraph. Lettering as in Fig. 21.

FIG. 23.



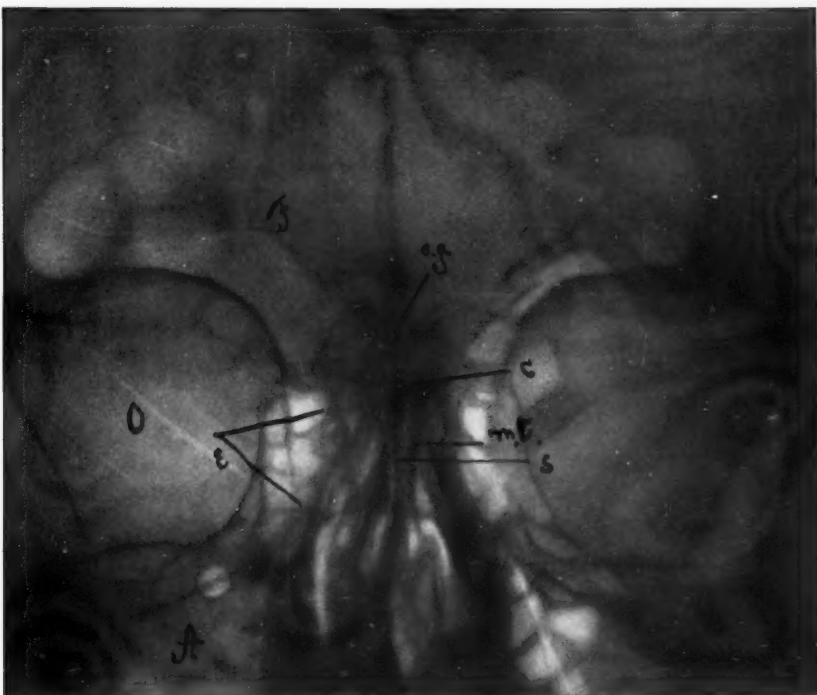
Lateral skiagraph. Lettering as in Fig. 21.

FIG. 24.



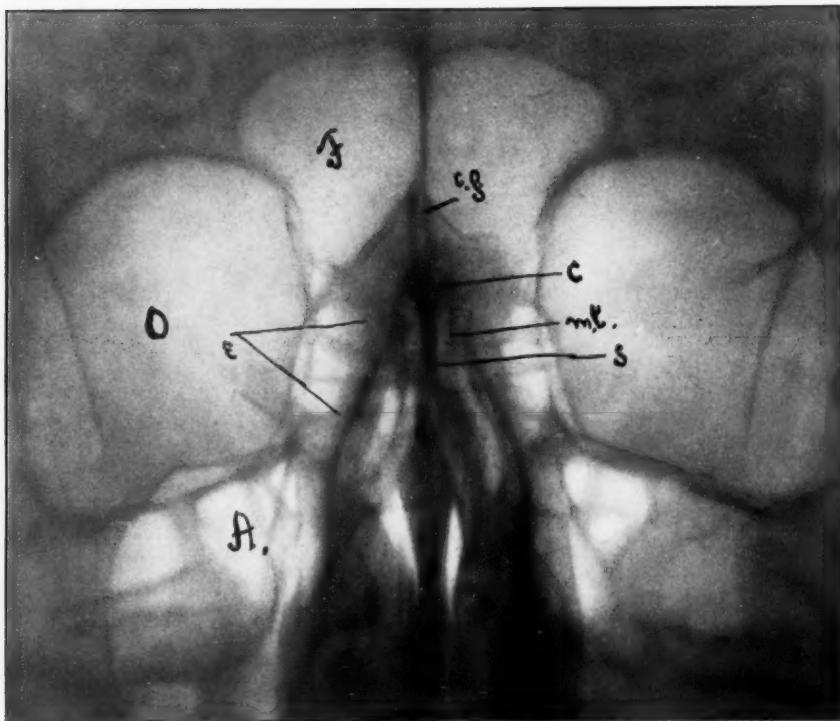
Lateral skiagraph. Lettering as in Fig. 21.

FIG. 25.



Anteroposterior skiagraph. *F*, frontal sinus; *O*, orbit; *A*, antrum; *c.g.*, crista galli; *c.*, cribriform plate; *S*, septum of nose; *m.t.*, upward projection of middle turbinate; *E*, ethmoid cells.

FIG. 26.



Anteroposterior skiagraph. *F*, frontal sinus; *O*, orbit; *A*, antrum; *c.g.*, crista galli; *c*, cribriform plate; *S*, septum of nose; *m.t.*, upward projection of middle turbinate; *E*, ethmoid cells.

of the perpendicular ethmoid plate, nasal crest, nasal spine, and upper end of nasal bone. A little more lateral the floor has become much thinner posteriorly, but in front the nasal crest and upper end of nasal process of superior maxilla are still very thick. Sagittal sections (Figs. 3-6 and 21-26) demonstrate this very thick bony ring in the anterior portion of the sinus floor.

The arrangement of ethmoid cells below the sinus will not be considered here in detail because they have been considered so frequently in other publications. Those having particular bearing are in immediate relation with the lachrymal bone, the inner aspect of the nasal process, and the so-called agger nasi cell, often present at the extreme end of the middle turbinate.

The *internal* wall of the frontal sinus is the interfrontal septum and its extent and position and the existence of frontal septa should be determined by X-ray examination. The septum is practically in the median line, but of course is subject to some variation. Its central portion is thin and its circumference thicker, particularly below, where it continues as the septum of the nose (Figs. 5, 11 and 13). At its lower, posterior angle is the crista galli, which is separated by the posterior wall of the sinus. Occasionally the sinus itself projects into the crista galli, a fact which should be borne in mind. However, this angle is behind the guiding probe and should never be interfered with. The front corner of the cribriform plate may project well into this angle at the base of the crista galli (Figs. 9 and 17).

Hence, to summarize the practical points brought out by the above:

The region of the ostium of the sinus is surrounded by thin bone.

The whole nasal floor of the sinus represents the maximum area for the acquiring of drainage.

The area posterior and internal to the ostium is comparatively small, and it is too dangerous a region for interference, although, with great care, a protruding ethmoid cell may be destroyed.

The area in front and external to the ostium is by far the larger and is comparatively thick and dense. All of this may be removed with comparative safety by means of special instruments.

The partition between the sinuses and its continuation into the nasal septum (perpendicular ethmoid plate) may also be removed without risk and thus extra space be gained.

X-ray examination in two planes must be made before operation, in order to determine certain relations which are variable.

A clear understanding of the lymphatic and venous channels of drainage is necessary in order to determine subsequently the extent and location of infection. There is some drainage into the superior longitudinal sinus and also into the lymph-vessels of the cranial cavity.

Röntgenologic Examination.—The Röntgen portrayal of the conditions in and about the sinus is of great importance, partly as an aid to diagnosis, but particularly as a means of determining the site and dimensions of the sinus.

Slight pathologic changes in the region could not be detected, but extensive alterations in the density would be evident. Hence, as an aid to diagnosis, the skiagraph may be of some value, but other signs are of greater importance. I believe the chief value of X-ray examination is the portrayal of the anatomy of the region, for thus we are enabled to picture anatomic features of paramount importance. The site of the sinus can be established so that the exploratory opening can be made with the assurance of entering it. The lateral views will determine the amount of space between the front end of the cribriform plate and the base of the nose, a factor of great importance in the technic to be described.

Two views should be made—an anteroposterior and a lateral one. More than ordinary precision is required, both as to symmetry and point of focus. Dr. Percy Brown has devised an apparatus for fixing the head and obtaining most satisfactory skiagraphs in these difficult cases, and to him I am also indebted for the illustrative prints ("The Diagnostic Evi-

dence Obtained from X-rays from the Lateral Aspect of the Skull." *Boston Medical and Surgical Journal*, June 12, 1913). Anteroposterior views give us the height of the sinus, the level of the cribriform plate, and the width of the space between the lachrymal bones. The lateral views show all the antero-posterior dimensions, particularly the available space for enlarging the opening, and the position of the crista galli and the front end of the cribriform plate. The base line of the cranial cavity can always be demonstrated.

Transillumination is not of much diagnostic or operative value, and reveals nothing that cannot be discovered by other means. A sinus filled with pus or hypertrophied tissue or a small sinus might be suspected as a result of such examination. No operative guides can be made out. Hence contributory evidence may be obtained.

Technic of Operation.—Preliminary to any external operation upon the sinus, effort to cure by intranasal methods along safe lines should have been thoroughly tried. This means that the front of the middle turbinate has been removed and many anterior ethmoid cells broken through. X-ray findings should have been carefully studied. Application of a four per cent. solution of cocaine and adrenalin (1-2000) to the extreme upper front portion of the nasal cavity will lessen materially the amount of hemorrhage. The usual bone cutting instruments and slender curettes should be selected, but the essential portion of the operation is performed solely by means of burr drills of selected sizes mounted on curved and straight shanks. The burr drills devised by Tilley and Ballinger for antrum operations serve our purpose well, particularly those with the curved shank.

The patient is placed in a sitting posture and the head kept horizontal most of the time. There is less shock when the patient is placed semirecumbent, and this position may be selected, but greater caution is needed to keep in mind the anatomic relations and hemorrhage may be more troublesome.

In order to avoid the annoyance of blood escaping into the pharynx, the posterior nares may be plugged or, better still,

narrow strips of gauze may be introduced *via* the anterior nares, leaving the front half of the nasal fossa free for operation. Ether should be administered through a tube entering the mouth to the pharynx, so as to avoid any delays or annoyance from this source.

The incision is the middle portion of the one used in the Killian operation and, in fact, the one adopted for most of the frontal sinus operations. It extends from about the centre of the unshaven eyebrow inward and then downward a short distance on the outer side of the nose. The supra-orbital nerve may be spared in some cases (Fig. 19). An area of bone at the base of the nasal process and nasal bone and above is exposed and denuded of periosteum. The sinus should be entered just above the base of the nasal process (Fig. 2), easily accomplished by means of small chisels and gouges, and enlarged by rongeur forceps. The sinus is then explored by means of a small probe. The ostium will be found situated toward the posterior angle. Pass the probe down into the nose and out the anterior nares. The upper end should protrude through the wound and be bent so that the probe will stay in place of itself. Pass small curettes from above down through the floor of the sinus, always in front of and external to the probe at the ostium. Thus, the thin walls of anterior cells are broken up until the ostium becomes considerably enlarged. During these manipulations or earlier the walls of the sinus should be freed from excessive granulation tissue or polyps, if such be present. If the mucous membrane of the sinus is not materially hypertrophied, it is probably better not to curette it, for thus we obtain a better chance for resolution after the lower obstruction is removed. However, if there is much hypertrophy, ulceration, etc., the thickened portion should be curetted, but the periosteum of the lining of the sinus should not be removed. If distal portions of the sinus are already practically obliterated by dense scar tissue, do not disturb it.

The object of this minimum of curetting is to impair as little as possible the nutrition of the bony walls of the sinus

and thus avoid subsequent necrosis. After a short time the sinus hemorrhage will be practically arrested and the vicinity of the ostium can be inspected. Almost all of the subsequent work is performed by the burr drills, introduced chiefly through the nose so that the burr is almost always in sight. These instruments are to be used just as a dentist reams out the carious portion of a tooth. No other instrument can be used for this purpose, because the part to be removed is otherwise inaccessible, and the use of chisels and rongeurs would be dangerous and inexact. The burr gnaws away the bone with precision and safety. At first the smaller burrs are introduced through the anterior nares to the region of the guiding probe. First, the nasal crest is removed and the process continued anteriorly toward the nasal bone and nasal process at about their upper suture line. As the opening becomes larger the larger burrs can be used. By this means this portion of the nasal bone and the nasal process of the maxilla, together with the adjacent part of the frontal bone becomes very thin and there remains only a bony shell around the circumference of the enlarged ostium. It is surprising how large an opening can thus be obtained. By means of the burr drill and a curette the ethmoid cells, which may be present at the upper end of the infundibulum and opposite the lachrymal bone, and the agger nasi cell should be destroyed. While working opposite the lachrymal bone, the finger should be pressed gently in the inner canthus to serve as a guide and for protection. The lachrymal bone and the external surfaces of the ends of the nasal bone and nasal process should not be broken through, for these thin shells will serve to keep the region of the ostium from sinking in. This I believe to be the usual cause for failure in the modern radical operation where this portion of the wall has been destroyed.

Recent cases operated upon have demonstrated the wisdom of making use of the combined nasal floor of both sinuses, even though only one sinus is pathologic, in the manner described below for operation in cases in which both sinuses are involved. The mucous membrane of the healthy sinus does not become

diseased and the proximity of healthy mucous membrane favors early epidermization. Furthermore, the single opening in the facial wall gives ample opportunity for the complete operation, because we do not care to reach the distal portions of the normal sinus. A large part of the interfrontal septum is removed and, if desired, we could readily probe and curette the healthy sinus.

If both sinuses are involved, the opportunity for a large opening is most excellent. The X-ray findings have already shown the topography of the sinus and, in particular, the distance between the crista galli region and the anterior contour of the sinus and also the extent of the interfrontal septum. The opposite sinus may be opened and its ostium enlarged in the manner described above. Then this septum is perforated in its thin, central portion and its anterior and lower portion enlarged with the burr, gradually approaching the floor of the sinus. We are now at the base of the bridge of the nose, behind which is much dense bone in the vicinity of the median line where the septum of the sinuses and that of the nose meet. This can be removed readily with the burr in view, leaving a thin protecting shell of bone in front. The portion of the septum of nose just below the sinuses should be removed also with the burr. This is made up of the perpendicular plate of the ethmoid and is to be removed for a depth of nearly one inch (Figs. 5 and 13). As in any sinus operation, the posterior angle of the sinus and the region of the front end of the cribiform plate should be avoided at all times. It is surprising to observe in the average sinus how much space for drainage can thus be obtained. From below a comparatively large instrument can be swept across from one sinus to the other and from either nostril into either sinus. The removal of this median partition adds so much more to the efficiency of the drainage that I believe it should be done even in cases where only one sinus is involved. It may, at first thought, seem an unwise step but I believe it will work for good and not harm in every instance. A sinus is opened frequently for exploration and generally without ill effect but, if any harm does

follow, it is because of accumulated blood clot which cannot escape and which becomes infected. In these cases where the opposite side is opened, there is no chance for retention and the healthy mucous membrane does not become infected and pus is not retained. This is on the same principle that an antrum may act simply as a reservoir in frontal sinus suppuration and give no further trouble after the latter is cured. Furthermore, the chance for drainage is poor compared with that of the frontal sinus treated as above. Besides obtaining a very large opening, another advantage of connecting the sinuses is the fact that the mucous membrane of the healthy side allows epidermization in the vicinity of the new ostium on the diseased side. In skilled hands the whole operation can be accomplished through a single external opening, although a double opening is safer.

By the time the operation is completed the hemorrhage has practically ceased. With the head tipped forward, the external wound should be washed with a sterile solution and the skin incision closed. The tampons are to be removed from the nose and a compress bandage applied. The after-treatment is the same as in any case. Irrigation should be avoided for several days. As the intranasal areas begin to granulate around the ostium they should be kept clean and smooth by the usual methods. The whole sinus cavity is now particularly accessible for treatment.

The Closure of Fistulae.—Fistulae are the result of obstruction at the ostium and may arise spontaneously or after operation. If the ostium becomes occluded during the course of an acute inflammation and remains so, an empyema or practically an abscess results, which in turn will cause a perforation of one of the walls of the sinus. An external fistula results if the perforation takes place through the facial or orbital wall; this tends to last indefinitely until corrected by operation. Following operation, where an attempt has been made to enlarge the ostium, a fistula may develop in the line of incision. This may appear after a few days, weeks or months, and is due to the fact that the opening has become obstructed, partly by

œdema and later by granulation tissue at the site of the ostium. These external fistulæ will remain closed only after a permanently patent ostium has been established by some means or other. It is fair to assume that this complication occurs in the obstinate cases which require more careful and radical treatment. Here again the operator must decide whether he will attempt to obliterate the sinus or establish a large ostium.

Epidermization of the Sinus.—During the operation upon one of the obstinate cases, where an external fistula had existed in each sinus for over a year, Dr. O. A. Lothrop suggested the possibility of epidermizing the frontal sinus as is sometimes done after mastoid operations. I do not know that this has ever been attempted in the frontal sinus, but I felt that if the vicinity of the ostium could be protected with epithelium it would lessen the chance of granulation obstruction and the flap would serve as an island whence epithelium would tend to spread in all directions over the remaining sinus wall, as after the manner of any skin graft. This case was particularly obstinate because the supporting wall of the upper part of the lachrymal bone and nasal process had been removed by previous operators.

The following technic was devised and carried out and the parts have remained closed, an interval of twenty months having since elapsed. Just how much spread of epithelium has taken place it is impossible to determine. The sinuses were large and at the present time there is no discharge and the patient considers himself cured.

The steps are as follows, as illustrated in Fig. 20: After the vicinity of the ostium has been enlarged to as great an extent as the anatomy will allow, as described above, the edge of the skin of the upper lid is sutured to the periosteum on the outer edge of the bony opening into the sinus with small catgut (Fig. 20, *b*) ; then an oval incision is made in the lid down to the muscle fibres, so as to form a flap about the size of the opening in the bone. The blood supply of the lid is excellent and the flap is very movable so that it turns readily without much cutting after division of the thin skin of the lid. The

flap is now to be turned so as to cover the bony opening and is sutured to periosteum, preferably with fine chromicized cat-gut. Then the parts are washed carefully with a sterile solution and the remaining wound is closed. The lid is to be drawn across horizontally and it will be observed that there is very little tension and subsequent oedema, and that the motion of the lid is not interfered with. In the two instances where the sinus was grafted, the scar is scarcely perceptible in one and in the other the depression is moderate and is due to the previous extensive destruction of bone.

This paper is designed to present general principles and a technic for operation. A list of cases operated upon is not included, as thereby nothing would be added to what has already been said.

BLEPHAROPLASTY BY A PRE-GRAFTED FLAP.*

BY CHARLES GIBSON, M.D.,
OF NEW YORK,

Surgeon to the First (Cornell Med. College) Surgical Division of the New York Hospital.

IN the late nineties while acting as surgeon to the Work House and Almshouse Hospitals I had several opportunities to see the end results of plastic operations performed for the relief of tissue defects resulting from excisions of epithelioma of the eyelid. These were, in general terms, very bad, very unsightly, and very uncomfortable. The plastic flap in most of these cases was tightly stretched across the eye-ball and adherent to the conjunctiva, causing discomfort and distress and lamentable cosmetic appearances. It occurred to me then that in attempting to reconstruct the eyelid we ought to keep its functions in mind and try to reproduce them in any reconstruction work.

A proper eyelid is, of course, smooth, is lined with an epithelial layer, in this case representing the mucous membrane of the conjunctiva, and of course is free from the eye-ball. It seemed to me, therefore, that any transplanted flap which was to replace a gap in the eyelid should have an epithelial lining. This epithelial lining could, of course, be supplied by applying a skin graft to the back or raw surfaces of a pedunculated flap and there is sufficient evidence that epidermis transplanted into mucous lined cavities assumes to a sufficient degree the characteristics of the mucous membrane.

I found that quite naturally the same idea had occurred to others; that is, after plastic flaps had been made, to fill the gap in the eyelid, a skin graft was put on the reverse side. Personally, I never had any opportunity to verify the results, good or bad, of this procedure, but I knew from general experience that skin grafting under these conditions gave no

* Read before the American Surgical Society, April 11, 1914.

assurance of successful union. I determined, therefore, to devise a method which would allow the transplantation of a flap which already satisfied these conditions.

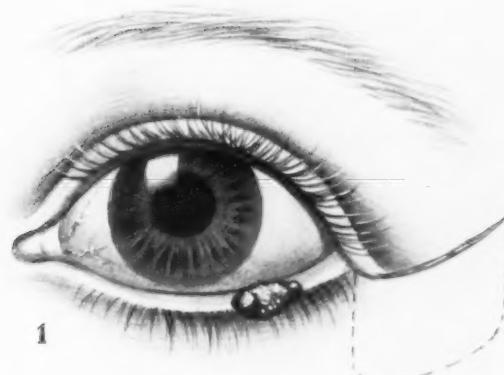
My first case, Lena W., presented herself ten years ago and gave me the opportunity to carry out these theoretical requirements. In her case I deliberately chose to utilize the form of plastic advised by Dieffenbach, which I believed would assure me the best kind of flap with which to carry out the preliminary grafting, although the flap itself, having a pedicle lying vertically below the eyelid, possessed the disagreeable feature of drawing down the eyelid and the result was not any too satisfactory on account of the inherent defects of the flap, although the requirements, namely, a movable eyelid with the internal surface lined by epithelium and nonadherent to the conjunctiva, were obtained. In my second case I chose to make the flap recommended by Fricke but more nearly horizontal, and the result was so satisfactory that it is this operation that I describe and recommend.

We start out then with the idea that we shall outline the flap and prepare it by grafting its inner surface and only remove the lesion (epithelioma) and transplant the flap into the resulting cavity when the flap shall have been demonstrated to be properly prepared to take the place of the eyelid. A two-stage operation then becomes a necessity. The various steps of the operation are readily understood by a study of the accompanying illustrations. The preliminary operation might be done, if necessary, under local anaesthesia but I should prefer it to be under a general anaesthetic, as was done in both cases, so that the outlines of the flap should not be obscured by infiltration of cocaine or possibly the wound healing so jeopardized. The first step consists in making an incision through the whole thickness of the skin, starting at the external canthus and running somewhat obliquely upward for a suitable distance, according to the size of the flap required. In my two cases the lesion occupied the external half of the lower lid and a flap one and three-quarters inches was outlined. Fig. 1 shows the single incision through the skin, the dotted lines show the area of the proposed flap. By dissecting down through

the preliminary incision a pouch is made corresponding to the size of the eventual flap and into this the skin graft can be tucked, just as one places a handkerchief in the pocket. A single skin graft of suitable proportions is cut and is introduced into the pouch, as shown in Fig. 2. It is a little larger in its vertical diameter than is necessary, allowing the top portion to be turned over on the raw edge of the flap. That completes the first stage of the operation. A protective dressing is applied and the graft is allowed to heal in place and the transplantation is not made until the healing is an accomplished fact and no raw surface exists. That would ordinarily take about 10 days.

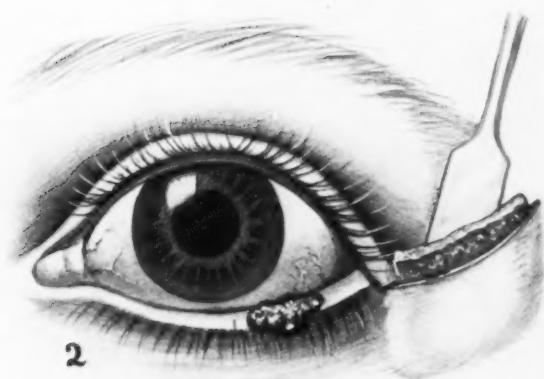
At the second operation the epithelioma is excised by removing the outer half of the eyelid by a quadrangular incision, the outer vertical leg of which just impinges on the skin out of which the pre-grafted flap is composed (Fig. 3). In Fig. 4 is shown a horizontal incision parallel to the first original incision, thus freeing the flap and allowing it to be slid over into the gap left by the excision of the epithelioma. Fig. 5 shows the flap sutured into place and the operation completed. The healing takes place readily in less than a week. The after-results have been satisfactory, as can be seen by the photographs of these patients. While the result in patient one is not quite satisfactory it is because the poor type of flap was used, but even then the advantages of the pre-grafted flap are obvious in that there is a free palpebral margin lined with a perfectly satisfactory substitute for mucous membrane which it now closely resembles. The preliminary operation allows for the occurrence of a normal shrinking of the flap and in making these flaps it is only necessary to cut them of the exact size necessary to fill the gap. This fact I learned by experience in these two cases where in each instance following the general principles of plastic surgery, the flaps were made over-generous with the expectation that they would subsequently shrink. This shrinkage did not occur and in both cases we have an over-generous palpebral opening. Ten years in Case 1 and seven years in Case 2 have elapsed since these operations, and

FIG. 1.



1

FIG. 2.



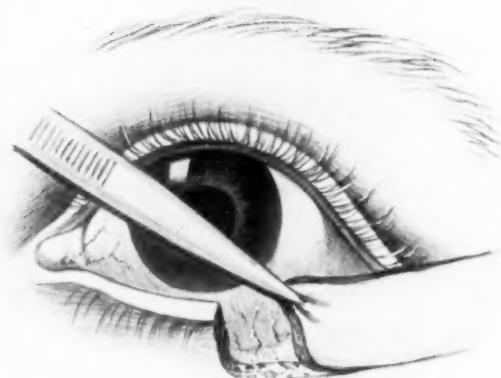
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FIG. 3.



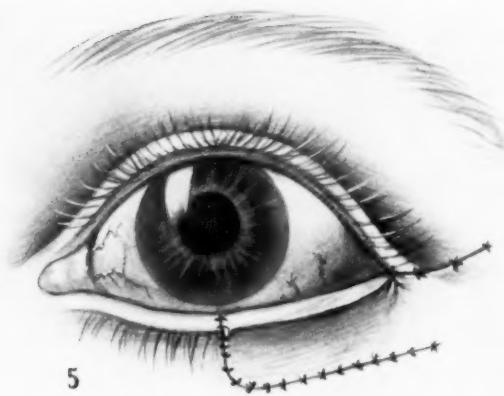
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FIG. 4.



4

FIG. 5.



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FIG. 6.



Case I. Ten years after operation.

FIG. 7.

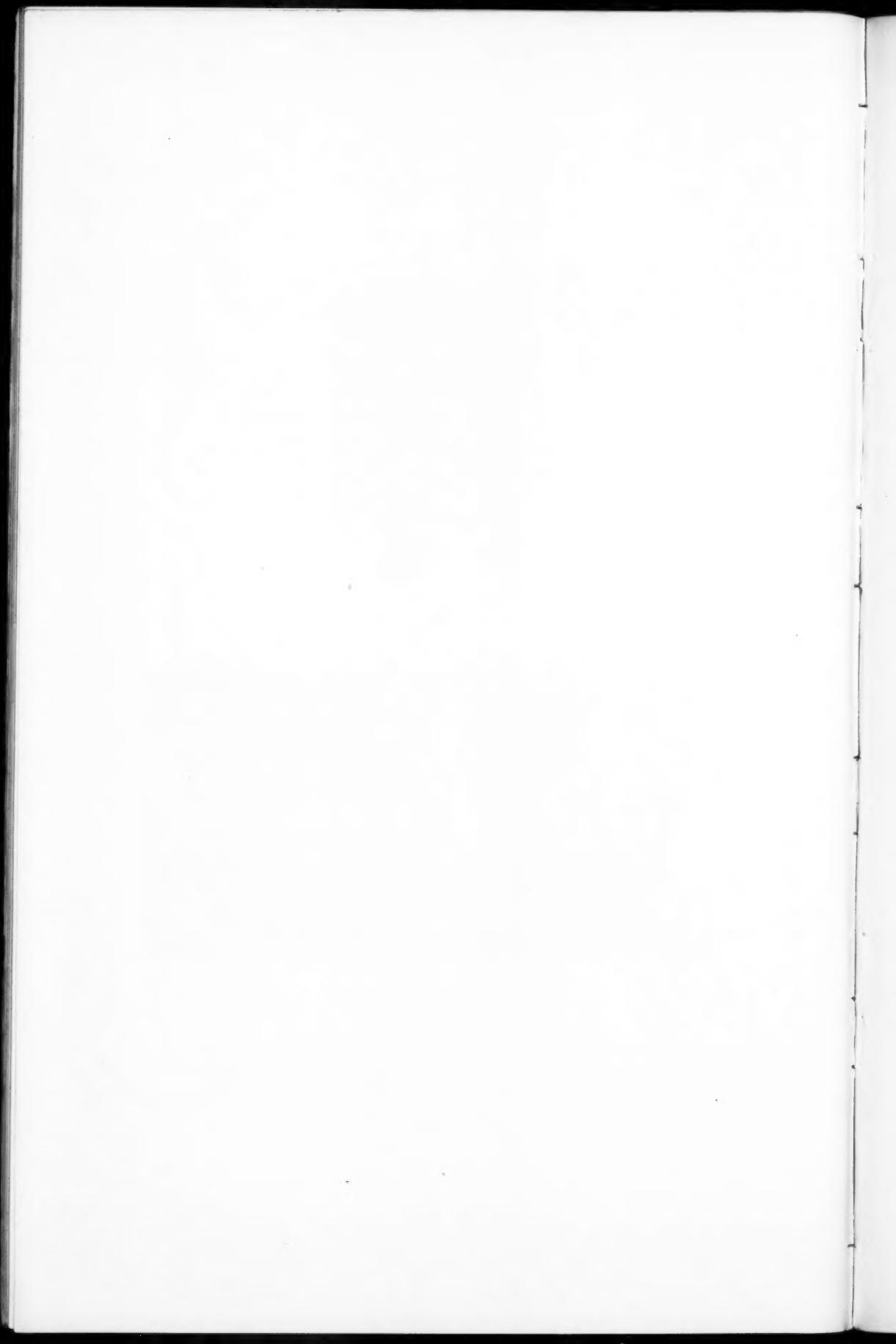


Case II. Before operation.

FIG. 8.



Case II. Seven years after operation.



in all that time the flaps have not shrunk or altered in any way.

Since the advent of various therapeutic measures destined to compete with surgical procedures in the removal of epitheliomata involving the eyelid, such plastic operations have perhaps enjoyed less popularity than formerly and, if one recollects the miserable results obtained by the former conventional methods, it is not surprising that there should be a temptation to utilize X-ray, radium, and other methods of less proved efficacy. It must be borne in mind that the patients here presented have not only satisfactory eyelids, but can be presented after the lapse of years as cured of their epitheliomata, whereas at the present time no similar assurances can be given for the value of the competing methods.

LIGATION OF THE INNOMINATE ARTERY.

WITH REPORT OF A SUCCESSFUL CASE.

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CONSIDERATION of the infrequency of ligation of the innominate artery has led the writer to place upon record the history of the following case:

Mrs. K., aged sixty-eight years, referred by Dr. H. H. Webster, presented herself on January 11, 1913, complaining of severe pain about the right shoulder and in the right arm, and of a pulsating swelling above the clavicle.

She had always been a hard working woman, had not been addicted to the use of alcohol and there was no history of lues nor could there be found any evidence that there had ever been a luetic infection, though a Wassermann test was not made.

Her present trouble was noticed a month or six weeks before coming under observation, pain and difficulty in using the right arm being the first disturbance. Early in January, 1913, she detected the pulsating swelling.

Physical examination did not reveal any pathologic condition except a moderate arteriosclerosis and the enlargement above the right clavicle. The swelling, which was about the size of a hen's egg, presented all the characteristics of an aneurism of the subclavian artery. There was no apparent disturbance of the circulation in the arm, except the pain and certain paræsthesiæ; no evidence of nerve lesions beyond what could be accounted for by the pressure of the aneurismal sac on the brachial plexus.

She was at first treated by keeping her in bed, on a reduced diet, with limitation of the amount of liquid ingested and the administration of small doses of iodide of potassium.

On February 6, 1913, an attempt was made to insert fine silver wire into the sac; only about 8 inches of wire could be passed, however. This was cut off flush with the skin and has of course remained *in situ*.

No improvement in the local condition was effected and on February 10, 1913, she was operated upon, under ether anaesthesia.

An incision was made along the anterior border of the sternocleidomastoid down to the sternoclavicular articulation, and another one along the clavicle; the triangular flap of skin, superficial fascia and platysma was dissected up; after division of the deep fascia, severing the origin of the sternomastoid muscle and clearing away some of the loose fat, a good exposure of the aneurism and the deeper structures was obtained. The aneurism involved the third part of the subclavian artery, extending, however, behind the scalenus anticus muscle and encroaching upon the first part of the subclavian. It was accordingly deemed unsafe to apply a ligature to the first part of the subclavian and ligation of the innominate was decided upon.

The sternohyoid and sternothyroid muscles were severed and raised upward; about 2 inches of the clavicle were resected and the innominate artery was readily exposed. A heavy, braided double silk ligature was placed around this vessel, about $\frac{1}{2}$ inch below the bifurcation, and tied with an ordinary surgical knot; as the knot was being tied the coats of the vessel could be distinctly felt to give way, though only very moderate force was used; evidently the vessel wall was markedly atheromatous. Pulsation of the sac at once ceased completely. The common carotid was also tied, about one inch above its origin, with No. 2 chromicized catgut. The wound was accurately closed, except for a small drainage opening at the inner angle, and the dressings so applied as to obliterate dead spaces. The arm was wrapped in cotton. The patient made no complaint of coldness of the limb subsequent to the operation, and there was no oedema or disturbance of the nutrition. The wound healed by first intention. There was at no time any evidence of disturbed cerebral circulation. The sac rapidly became consolidated and firm. Some pain and paresthesia persisted for several weeks.

On June 29, 1913, it was noted that but little trace of the aneurismal sac could be felt; there was no pulsation of the radial or brachial arteries; the hand was colder than the left and the skin of the palm apparently smoother and somewhat atrophic. There was some pain about the end of the clavicle, probably due to the adherent scar.

The patient was examined thirteen months after the operation and found to be in good general health; her weight has increased,

she works every day, and has no pain. No trace of the former aneurism can be felt, and the radial pulse is absent; there still seems to be some paraesthesia of the forearm and fingers. An examination of the chest fails to reveal any evidence of an aneurism of the arch of the aorta or any of its branches.

Observations on the blood-flow in the upper extremities were made by Prof. G. N. Stewart.¹ A note from him is as follows: "The blood-flow in both hands in Mrs. K. is greater on July 9, than at the previous examinations (March 20 and March 21). The ratio of the flow in the right to that in the left hand is 1:1.3 on July 9, while at the previous examinations it was 1:3.5. The relative increase has therefore been much greater in the right than in the left. Immersion of the left hand in cold water causes now a marked diminution in the flow in the right, indicating that an appreciable (and no doubt the greater) part of the total resistance of the path is now in the smaller vessels of the anterior limb. The arterial channels feeding the arm are therefore now comparatively wide. The flow in the right is absolutely as great (over 8 grammes per 100 c.c. of hand per minute with room temperature 26 C.), so that the symptoms now observed in the hand cannot be due to the small blood-flow."

As is well known, the innominate artery was first ligated by Valentine Mott in 1818. Sheen,² in 1905, collected 36 cases, including one of his own, and Burns,³ in 1908, collected 10 more cases (one of them his own), bringing the number up to 46. I have been able to find references to the following additional instances: Myles,⁴ one case unsuccessful, Saigo,⁵ two cases (successful), Ballance,⁶ two cases (one successful), Sargent,⁷ one case (successful). These, together with my own case, bring the number up to 53, of which 14 were successful (26.4 per cent.). Only one of the recoveries, that of Smythe, dates from pre-antiseptic times. Tables are given by Sheen and Burns showing details of the cases up to 1908.

Allan Burns in 1811 demonstrated that the vessels of the head and the right arm could be fully injected after ligation of the innominate artery in the cadaver, and in looking over the published cases of the ligation of this vessel during life, no instances of gangrene could be found, though disturbance of the cerebral circulation occurred a number of times.

The most common cause of death has been secondary hemorrhage, which occurred in one instance as late as the sixtieth day after operation; this can be readily understood, as the majority of operations were done in pre-antiseptic days; however, secondary hemorrhage is still a large factor in the mortality record of the more recent cases.

The cases above referred to are, of course, very unequal in value for forming an idea as to the advantages and disadvantages of ligating the innominate artery and in deciding which plan of procedure is to be adopted in a given case. Most of the operations were done in pre-antiseptic times; the position and size of the aneurism was quite variable; in some a greater or lesser degree of arteriosclerosis existed; the ligature material varied; other vessels, such as the common carotid and vertebral, were frequently tied in addition; in two instances, at least, the aneurismal sac was extirpated after the ligation of the innominate for return of pulsation.

For the cure of aneurism of the right subclavian artery, which is the most common indication for the ligation of the innominate, some eighteen different operative procedures have been practised according to Jacobsthal⁸; to these may now be added the Matas method.

It is not the purpose of the present writer to discuss these methods. Cures have been accomplished by most or all of them, but it cannot be said definitely which is the method of choice. It may be noted that peripheral ligation has proven quite successful; Savariaud⁹ has collected nine cases, all followed by recovery. It is the opinion of many writers that extirpation of the sac is the ideal method; both extirpation and the obliterative method of Matas are based upon the underlying principle, established by Antonio Scarpa, that the artery should be obliterated at the site of the aneurism. However, there are cases in which these methods can for some reason or other not be adopted and ligation of the innominate, which is now established as a feasible and reasonably successful operation, will have to be resorted to.

A few details in the performance of the operation may be briefly alluded to.

To gain access to the vessel, an incision along the anterior border of the sternomastoid, joined by another over the clavicle, has been the one most frequently adopted; the flap having been dissected up, the attachments of the sternomastoid are divided and also those of the sternohyoid and sternothyroid; the common carotid having been exposed, it is followed to its origin from the innominate. Ordinarily, the bifurcation is high enough to enable one to reach the vessel without removal of bone; however, excision of the inner part of the clavicle will materially aid in exposing the vessel and in giving more room for the deeper dissection. Milton¹⁰ proposed longitudinal division of the sternum and forcible separation of the two parts in order to gain access to the anterior mediastinum; this seems to me an unnecessarily severe procedure, at any rate for ligation of the innominate. Bardenheuer recommended osteoplastic resection of the manubrium; the flap is hard to make, however, and is apt to suffer in its nutrition and necrosis may result. Removal of the right half of the manubrium and adjoining costal cartilages, and perhaps also the inner end of the clavicle, may be resorted to.

In clearing the artery injury to the innominate veins, the vagus and the pleura must be carefully avoided; and this is best accomplished by keeping close to the common carotid and innominate arteries and gently displacing the structures mentioned.

There has been considerable discussion concerning the character of ligature material to be used, the kind of knot to employ, whether to use two separate ligatures, a short distance apart, how firmly to tie them and whether or not the common carotid and other vessels should also be tied.

Provided rigid asepsis be maintained, it probably makes little or no difference what ligature material is employed; personally, I believe, that the ligature should be tied firmly enough to divide the inner coats and that the common carotid should also be tied, and perhaps the vertebral, as it is reasonable to assume that thus a return of pulsation in the aneurismal sac will be more likely avoided.

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DISTANT RESULTS OF A SUTURE OF THE HEART FOLLOWING A WOUND BY PISTOL-SHOT.*

BY ROBERT PROUST, M.D.,
OF PARIS, FRANCE.

FOUR years ago I operated on a youth, fifteen years of age, for a wound of the heart.

He was able, after being cured, to return to his normal mode of living. Since the operation I have never lost sight of him, as he comes to see me regularly.

Lately, more than four years after the intervention, I have been able to examine with details, thanks to radioscopy, radiography and electro-diagnostics, the working of his heart. These are the results I shall have the honor to examine before you; but before doing so, I think it right to give you the details of this observation:

On February 20, 1910, being on duty, I was called at 5 o'clock in the afternoon for urgent service at the Trousseau Hospital, in Dr. Savariaud's ward, for a wound in the heart, diagnosis made by Messrs. Bloch and de Cumont, internes of the service.

On arriving, I saw a boy, thirteen years old, very tall for his age, who had been shot in the praecordial region. His condition was as follows:

At the beginning of the afternoon (at 10 minutes past 12 exactly), one of his little playmates had inadvertently pressed the trigger of a loaded pistol with which he was playing, and which fired at a distance less than one metre.

The blackish orifice, where the ball entered, is easily seen inside the nipple, and a rather wide streamlet of blood flows continuously from it. On auscultating, the beating of the heart is muffled but perceptible, the cardiac dulness seems to be enlarged at its basis. There is no sign of hæmorthorax. Traube's semilunar space is sonorous.

* Read before the American Surgical Association, April 10, 1914.

The pulse indicates about 100, but has a very bad tone, very unsteady in strength and rather undulating. The patient is extremely pale, in spite of numerous injections of serum and camphorated oil, of which the first were made by Dr. Gagnière, and which had pulled him through the great shock he had at the beginning; he is quite conscious, but is in great distress, a very acute dyspnoea, and intense thirst and a very great pain in which he called "the region of the heart." His physiognomy is imprinted with a striking anxiety. There are evidently symptoms which plead strongly in favor of a heart wound, especially the state of the pulse, but for once in a way it might be a question of simple shock. So, while everything is being prepared for the operation, I remain near the patient in order to closely appreciate the movements these divers symptoms are about to make.

After a rather long period of hesitation I have the impression of a progressive aggravation and decide on operation.

From the beginning I ascertain as far as possible the trajet of the ball. For this, after having traced a cutaneous incision according to Fontan's rule, I lift the skin and soft parts along the border of the sternum, and find the fifth costal cartilage shattered by the ball; I raise it and come across a mass of liquid blood, which bubbles and is animated by beating, I then quickly complete the flap by sectioning the fourth and sixth costal cartilages at their sternal insertion. The turning down outwards of the flap simply by elasticity is quite easy since it is question of a thirteen years old boy. I am very careful in this turning down to unfasten and push back the pleura; it was wounded by the shot at the level of the praecordial part and the passage of the air is heard at each respiration, I cover with compresses this breach of which the walls are too infiltrated with blood to allow of suturing.

Ligation of the two ends of the internal mammary and the sectioned intercostals. I then cleanse the operative field, and after having sponged much blood and tamponed the lower part of the wound (where the blood comes from) I clearly see the forepart of the pericardium, and by transparence above it, the forepart of the heart which slides at each beating, but seems to be separated by a thin liquid sheet. I then take away the compress which tents the lower part of the wound, that is to say, the lower part of the pericardium. A spirt of blood is produced immediately and I clearly distinguish the wound in the pericardium from which it comes. I enlarge this wound with my scissors,

both from the top and the bottom, to an extent of about 8 centimetres or about 3 inches, and mark the borders of the serous membranes with forceps after having isolated the operative field.

I am thus easily able to explore the pericardiac cavity, but at the level of the base I see only blood, and cannot distinguish the point of the heart. This is caused by the fact that all the base of the pericardium is filled with a *coagulum as large as the fist, which covers the point of the heart and compresses the heart upwards.*

I extract the coagulum, and with it the ball which was free in the pericardium. As soon as the coagulum is taken away the point of the heart appears freely with its pinkish white color; there is clearly distinguished a wound in the front residing near the left border quite near the point; a jet of blood escapes from it at each systole. Moreover, from the moment the coagulum is taken away, the heart begins to beat in a most immoderate manner, and it is with great difficulty that it is grasped. I am moreover troubled by the stock of instruments, for, at the beginning, I have at my disposal only a curved Reverdin's needle of the current model. It is with this that I quickly make my first stitch which perforated totally the wall of the heart; once knotted it stops the hemorrhage a little, but blood escapes along the thread. From this first stitch I am able to make three others non-perforating, by using this time the small Reverdin's intestine needle. I hide the first set of transversal sutures by a second plan of superficial sutures. I then turn the heart upwards to look for a second wound on the posterior face but I find none. But seeing the descendent obliquity of the traject of the ball, I come to the conclusion that it is a tangential wound although a penetrating one.

Suture of the pericardium with separated stitches of catgut No. 0: the lowest stitch fixes a very small rubber drain, which is level with the serous membrane and even penetrates into it at a little less than a centimetre; the drain has a vertical traject and comes out again in the lower horizontal branch of the cutaneous incision near the sternum. This drain was used on account of the relatively long time between the accident and the operation, and also on account of the finding of the bullet in the pericardium.

The flap is turned back (without suture of the pleura, which I find too infiltrated), and as I fear the edge of the lowest rib might wedge the drain, I protect the latter with a little tent of about 3 centimetres long, not going so far as the pericardium.

Reunion of the muscular surface with catgut. Fish-gut for the skin. Subcutaneous serum during the whole of the operation.

Operative Consequences.—Immediately after the operation the patient is taken back to his bed, in appearance hardly the worse for the operation.

The next day, February 21, there is a considerable thermic reaction. In the morning 39.8° Centigrade, that is about 103.6° Fahrenheit, and in the evening 40.4° Centigrade, or about 104.8° Fahrenheit.

In spite of this the general status is not alarming, the pulse indicates 110.

The following days there is a slight fall in the temperature which, however, remains very high.

On the ninth day, ablation of the small tent joined to the drain; immediately after this follows the escape of a reddish serosity, non-purulent, and of which the rhythmical flowing is isochronal to the cardiac beating (at this moment the temperature is about 102° , but the general status, which remains good, continues to disagree with this temperature).

Pulse indicates 96.

March 2 and 3.—Same status.

March 4.—The oozing tinged with blood which followed the ablation of the tent has stopped, the patient has a little chill, and in the evening the temperature is 104° .

March 5.—Messrs. Proust and Perinaud examine the patient in the evening; the pulse is very undulating, of very feeble tone and indicates 120. The heart-beats are exceedingly dull on auscultating, the patient has some trouble in swallowing, which has increased since the operation. Briefly, there are evident signs of pericardiac effusion. The small rubber drain, however, produces nothing. It is still solidly fixed in the depth and oscillates with the cardiac movements; I pull it away with a sharp tug and immediately out flows a great abundance of blood-stained serosity which is in no way purulent. The hand which palpates the radial pulse feels that little by little it puts itself right from this moment. It becomes pronounced, excellent, very strong.

From this moment the effervescence begins to cease, and finishes in less than 48 hours. The patient leaves the hospital on March 21, 1910, cured, one month after the operation.

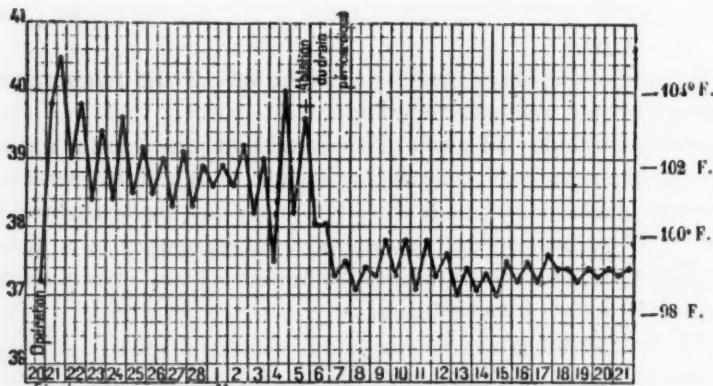
Examination on leaving the hospital: Temperature normal, pulse 80, the beating of the heart seems normal, the troubles of

swallowing have totally disappeared as well as the rising of the stomach which attended them.

The patient was presented at the Société de Chirurgie at Paris on April 13.

Immediately after his departure from the hospital, on March 21, 1910, he was engaged as telegraph messenger at the Post Office in Paris, and able to return to his normal mode of living.

FIG. 2.



Graphic.

He followed this calling of telegraph messenger during three years, and in spite of the fatigue experienced in climbing long staircases, he did not show any functional cardiac troubles; at the most did he notice, in the beginning, a little panting after hurrying upstairs. Since a year ago he has changed his profession. He is now a book-keeper and complains of no trouble whatever. Having his address I asked him if he would be examined in order to see if, a long time after the operation, our means of investigation would show, in spite of the total absence of functional disorders, anything abnormal, either at the level of the cardiac suture properly speaking, or as remains of the pericarditis he had shown.

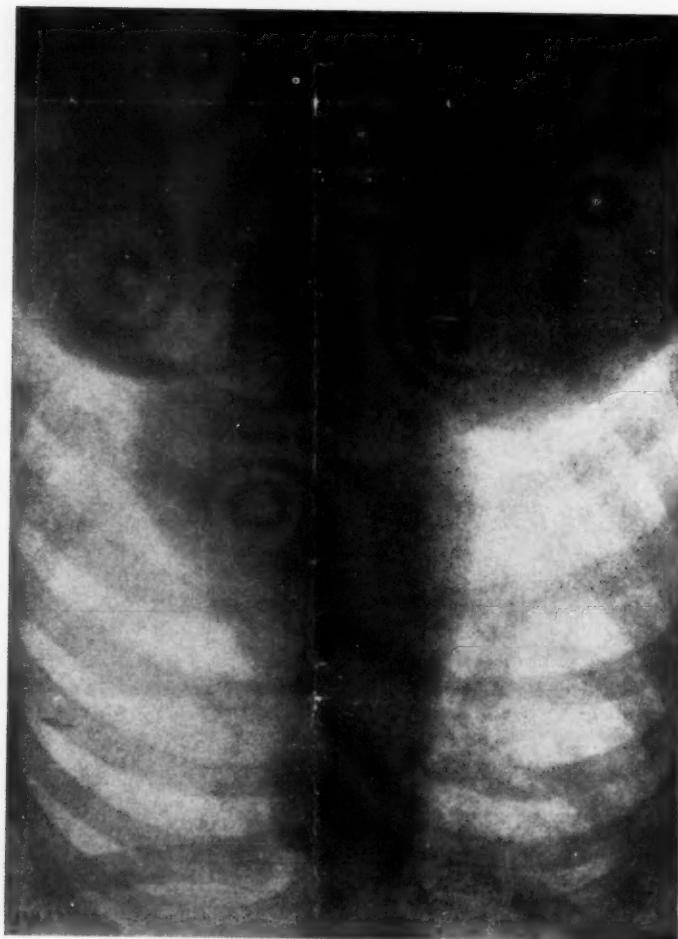
With this aim I asked my colleague and friend Dr. Bezaçon, chief physician at the Charity Hospital, to be good enough to consult him; Dr. Aubourg, chief of the Radiology Service at the Boucicault Hospital, to kindly radiograph him; Dr. Bourguignon, chief of the Laboratory of Electricity at the Salpêtrière Hospital,

FIG. 1.



Intrapericardiac clot and bullet extracted from the pericardium.

FIG. 3.



Radiograph.

to be kind enough to trace out his pulse, and Dr. Boulle, chief at the Marey Institute, to be kind enough to take his electrocardiogram.

The auscultation and electrocardiogram have established that the working of the heart was almost normal. But the point of the heart seems a little too near the sternum and the electrocardiogram shows a double bracket at the time of the ventricular contraction. The radioscopic examination has shown us very slight modifications consecutive to the sutures.

Here are the notes kindly provided to me by Dr. Aubourg:

Radiologic Examination.—The examination of the frontal region of the heart shows:

The left auricle has a normal aspect and volume.

The right ventricle has also a normal aspect.

The part of the left ventricle which forms the left border of the heart presents a normal shape; at the union of the external $2/3$ and the internal $1/3$ of the left border at the height of the fifth rib, is seen a permanent notch, which seems to be a fixed point which does not participate in the beating of the left border, as if at this level there were something which restrains the left border, such as retracted adherence. Moreover, below this notch, is seen, on the left ventricle itself, a circular zone of $3/4$ inch diameter, and which, by its clearness, shows up on the deep color of the remainder of the ventricle.

Afterwards, on practising divers oblique examinations, in order to judge the status of the left auricle and the posterior part of the left ventricle, it is seen that these cavities are neither deformed nor dilated.

The nature of the mark seen on the forepart is interesting to note; this might be an adherence of the pericardium, but one would not understand why the subjacent myocardium should not have preserved its thickness; so I believe it is question of an abnormally thin state of the myocardium following a scar, for example.

The second part of the examination bears on the oesophagus; the patient is placed in an oblique position, in order to distinctly see the clear space which exists between the vertebral column, the aorta and the heart.

The patient has absorbed a milk of carbonate of bismuth; the bismuth has designed an oesophageal duct of normal aspect as far as the origin of the large vessels. From this place, as far as the diaphragm, that is to say, over nearly four inches, we have seen a diminution of size of the duct, which can be estimated at a half of the normal calibre. When the bismuth got to the cardia we ascertained antiperistaltic movements several times and these movements are caused by a parietal lesion of the oesophagus. These are two objections against the supposition of a lesion of the internal tunic: first, the absence of dilatation above the stricture; second, the regularity in the diminishing of light, whereas in the lesions of the internal tunic there exists an essentially irregular canal.

We may, therefore, think that it is question of lesions of the external tunic, perhaps by adherences to the pericardiac pouch in relation with the auricles.

What does this examination prove?

That there incontestably remains some œsophageal troubles connected with pericarditis and that, on the other hand, there persists either a slight weakening of the cardiac wall at the level of the scar, or perhaps a pericardial adherence at this level.

These declarations obtain their value from the agreement of the two phenomena observed by Dr. Aubourg: first, the œsophageal troubles and the cardiac zone being lighter and more immovable, corresponding to the troubles of swallowing that the patient had experienced after the operation; second, to the precise passage of the bullet which had shattered the fifth costal cartilage.

The radioscopic ascertainings have indeed been established by Drs. Aubourg and Lebon, who were absolutely ignorant of the exact level of the wound in the heart and the troubles in swallowing that the patient had experienced after the operation.

Pericarditis continues to be the great obstacle to the perfect cure of wounds of the heart. In this particular case I willingly attribute its origin to the sojourn in the pericardium, during a prolonged time before the operation, of the bullet, which, it appears, not having a very considerable speed, might easily have got contaminated from the contact of the clothes or dragged a particle of dirt with it. It was, in any case, a very attenuated pericarditis, because the serosity was in no way purulent and the simple evacuation brought about the cure.

Although not a partisan of drainage in heart wounds, I believe that in this particular case, the fixing of a small rubber drain in the very orifice of the pericardium enabled us, if not by its presence, since it disappeared immediately, at any rate by its ablation, to obtain the result which would not have been obtained without it, except by a paracentesis of the pericardium. I believe there would be great interest in submitting to radioscopic and radiographic examinations patients who have been operated on for heart wounds, and by such, we shall get to know in precise manner the exact value of distant results.

A REVIEW OF NINETY-NINE ARTHROTOMIES FOR FRACTURE OF THE PATELLA.*

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TWENTY years ago our societies were discussing the justification of the open operation for fracture of the patella much as we are to-day considering the operative treatment of fractures of the long bones. It was then argued that the dangers of a stiff joint following the operation were so great that a patient had better accept a partially crippled joint with ligamentous union of the patella than to risk a stiff knee following the operation.

No less an authority than the late Dr. William T. Bull took this ground. Surgeons generally are now agreed that immediate operation on the patella is entirely right and proper, but we are still divided in regard to the other fractures.

If we can convert a simple fracture of the patella into a compound one and at the same time expose the great knee-joint filled with fluid and clotted blood, without great risk, why should we hesitate to expose other fractures? The answer is, that in the treatment of the long bones we are influenced not by the fear of sepsis, but rather by the knowledge that satisfactory bony union, without operation, so generally results. The patella we know seldom can heal by bone because of the frequent interposition of fascia between the fragments.

As having some bearing on the question of the dangers of exposing fresh fractures to operation, I herewith present a review of cases of fracture of the patella, personally observed by me. The majority of the cases were operated by myself, while some were operated by my associates in the hospital service.

There were 101 fractures of the patella, and, with two exceptions, they were all subjected to the open operation.

One exception was a young woman of twenty-three, in whom, by indirect violence, the left patella was fractured transversely. After the accident she was able to stand, but not to walk. In this case the patient was very thin, the two fragments could be

* Read before the American Surgical Association, April 10, 1914.

distinctly felt, and crepitus could be easily elicited. The separation of the fragments was very slight. We felt that in this case the tendinous expansion of the vasti muscles had not been torn and that there was a fair chance for good union. There was also decided opposition on the part of the family to operation. The limb was placed on an inclined splint and the fragments held together by adhesive plaster placed about the fragments. The result was very satisfactory. A year later the opposite patella was broken, and although the separation of the fragments was greater, operation was not performed because of objection by the family. In this case the result was satisfactory, although at the end of six months there was some separation of the fragments, about half an inch. A year later this had not increased. She was able to walk perfectly well without aid. Seven years later the condition had not changed.

The other was a man over seventy years of age, who obtained a satisfactory result from similar treatment.

The operation has been performed within the first 48 hours after the injury, except in a few cases in which it has for various reasons been delayed to a later period. The operation has not varied except as to the skin incision. At first we made a straight longitudinal incision over the centre of the knee, but found that it did not give quite as good access to the lateral tears as did the curved incision across the joint. Our incision now begins on the inner side just posterior to the centre of the inner half of the knee and on the line of the joint, and is carried upward in a curve, passing about half an inch above the patella and then downward to the outer side of the joint to a point opposite the beginning. The flap includes the skin and all structures down to the patella tendon. This flap is dissected down to below the lower edge of the patella and gives a good exposure of the fracture and of the joint, and also what we consider most important, of the tear extending down on either side of the joint through the tendinous expansion of the vastus muscle. This tear is caused, in most cases, by the patient's efforts to walk after the patella has broken.

After all clots and fluid blood have been carefully sponged away, the fractured ends of the bone are thoroughly freshened and exposed by dissecting off that portion of the patella ten-

don which has dropped down and become adherent to the rough ends of the fragments. This we have never failed to demonstrate. We use for sutures chromic catgut No. 2. The first sutures are placed close to the edges of the fracture on either side. These are not tied until the rents in the lateral portion of the capsule have been accurately repaired. The first sutures are then tied so as to bring the posterior edges of the fracture together. If, when these sutures are tied, the anterior edges are separated by an eighth of an inch or more, we are better satisfied because then we are sure that the tying of the anterior sutures will surely give closer apposition of the fragments. The next suture is a sort of mattress suture. It is placed crosswise through the patella tendon above the upper fracture and then carried across the tendon below the lower fracture and tied. The effect of this is to take the strain from the transverse line of sutures during the recovery from the anæsthetic, when the great quadriceps muscle contracts. A final row of sutures is placed in the anterior layer of the tendinous expansion over the bone; the skin sutured with interrupted silk-worm-gut or continuous silk sutures. No drainage is employed.

The extremity from the toes to the upper thigh is placed in a plaster cast. This splint is left in place for ten days; it is then cut down on either side and the anterior half removed, leaving the posterior half as a permanent splint. At this time the sutures are removed and the patella grasped between the fingers and moved laterally. This movement of the patella is repeated every four or five days until the end of the third week, the patient being allowed in the wheeled chair after the second week. At the end of three weeks the cast is again removed and passive motion begun in the joint. The splint is then removed every night while the patient is in bed and re-applied in the morning. This allows of passive motion on the part of the patient when there can be no strain on the callus. If the patient resists the efforts of moving the joint to at least 45 degrees by the end of the second month, he is given an anæsthetic and under complete muscular relaxation the joint is forcibly bent to a right angle. There need be no fear of refracture in doing this, provided complete muscular relaxa-

tion is first obtained. This procedure is usually successful in bringing back a rapid return of the motion of the knee.

We advise our patients to use the posterior splint while walking for at least three months. After the second month while sitting in a chair we encourage them to have the splint removed and allow the leg to bend as much as possible.

In a few cases where the patient was exceedingly muscular we have used silver wire, believing that it would be better able to stand the strain of the muscular pull when the patient was recovering from the anaesthetic. In this we have been disappointed, for in two cases X-rays taken shortly after the operation showed the wire broken. We now use the mattress suture in the tendon, as above described, with satisfactory results.

In one case of refracture in a very muscular man, we made use of the Malgaigne hooks to hold the bone during the first week. In this case separation was quite wide and the hooks were found a very convenient way of bringing the fragments together and holding them during the suturing.

The following is a summary of our cases:

No. of patients.	Variety of fracture.	No. of fractures.
72	Simple of one patella.....	72
3	Compound of one patella.....	3
3	Simple of both patellæ at the same time.....	6
3	Simple of both patellæ at different times.....	6
2	Simple of the same patella twice.....	4
2	Simple of the same patella three times.....	6
1	Simple twice and compound a third time of same patella	3
1	Simple of both patellæ at different times, with refracture of one.....	3
—		—
87		103

There were 99 operations. All recovered from the operation. Two died while in the hospital, one on the twenty-first day of delirium tremens and one on the one hundred and twenty-seventh day of pulmonary tuberculosis. In both cases the anatomical result of the operation was satisfactory.

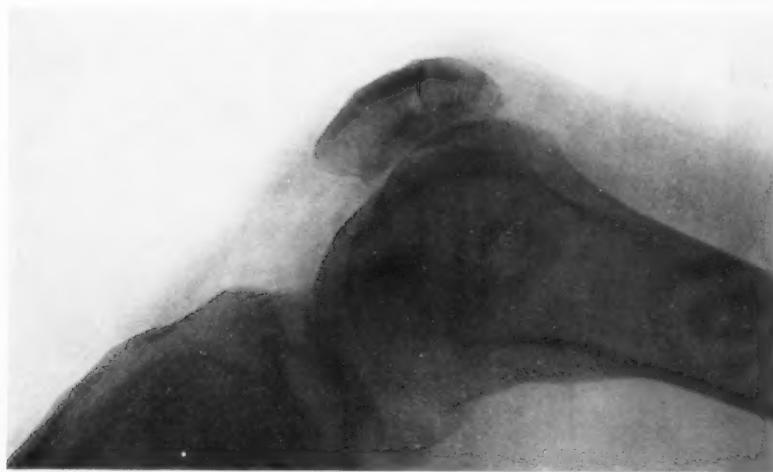
A number of the fractures were multiple, the bone being broken in from three to six fragments. This did not seem to make any difference in the result.

FIG. 1.



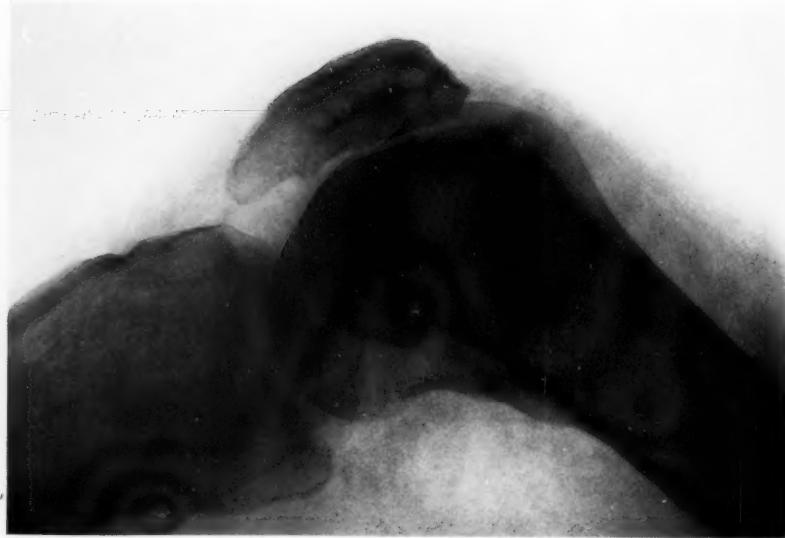
Left knee. Operated July, 1912. Useful joint, but flexion not to right angle.

FIG. 2.



Left knee. Operated March, 1911. Rheumatic patient, but by persistent massage good flexion was obtained.

FIG. 3



Left knee, operated August, 1909. Function of knee normal.

FIG. 4.



Compound fracture. Operated January 14, 1914. Good union. Motion still limited but improving.

FIG. 5.



Left knee. Joint motions good. The angle at which picture was taken gives an apparent distortion of joint.

FIG. 6



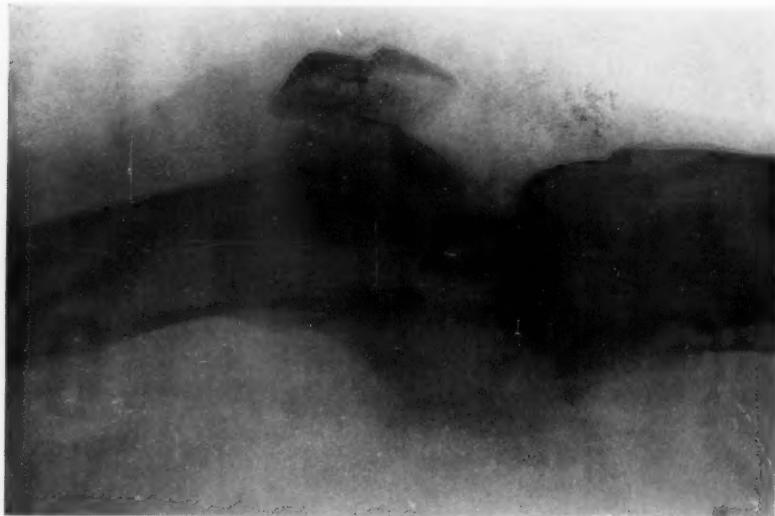
Right knee. Operated November, 1912. Perfect function. Simultaneous direct fracture of both patellæ, with fracture of fifth cervical vertebra and paralysis of left arm (see Fig. 7).

FIG. 7.



Left knee. Operated November, 1912. Perfect function. Simultaneous direct fracture of both patellæ, with fracture of fifth cervical vertebra, and paralysis of left arm (see Fig. 6).

FIG. 8.



Operated February 14, 1914. Good union. Motion in joint just begun.

There have been three cases of simultaneous fracture of both patellæ. In two the operation was done first on one side and later on the other. In one both patellæ were sutured at one sitting. This case was particularly interesting because it was a case of direct fracture, the man being thrown from a step-ladder by an electric shock. One patella was broken into five fragments and the other into three; the patient also sustained a fracture of the spine of the fifth cervical vertebra with resulting paralysis of the left arm. He made a perfectly uneventful recovery, and at the present time, 16 months after the operation, is able to get about as well as ever and to bend the knees to beyond a right angle.

In the cases of refracture, there had evidently been perfect bony union, for at operation the point of previous fracture could not be made out. In two cases we did not secure bony union, but in these there has been no tendency for separation of the fragments.

An interesting case was as follows: A very muscular man of 40 was brought to us with a fracture of the right patella. Eight years before this bone had been broken and successfully sutured by the late Dr. Bristow. In May, 1913, we resutured this bone and obtained an excellent result. He resumed his occupation the following August and was seen in September, when he had perfect motion in the joint and the knee looked normal except for the two scars. Three weeks later he was again brought to the hospital with a refracture of the same patella, the joint being badly infected. Drainage was instituted, extension applied, but the infection progressed and the femur and tibia both became involved. The process was finally terminated by an excision. This leaves him with a stiff joint, the only one we have in our series.

SUMMARY OF CASES TREATED FROM 1896-1914.

There were 87 patients with 103 fractures. Three cases were not operated, one refused treatment and was removed home. There were 2 deaths, neither directly due to operation. In 99 instances the fracture was exposed and sutured. Six have useful joints but with limited motion. Forty have flexion to at least a right angle and have perfectly useful joints. The remainder we have not been able to trace; all had motion to at least 45 degrees at the time of leaving the hospital, and in our experience this has always been followed by satisfactory motion if the patient persists in his efforts to move the joint.

THE NEW DRESS OF THE ANNALS.

ANNOUNCEMENT FROM THE PUBLISHERS.

OWING to the continually increasing amount of material of value, offering for publication in the ANNALS OF SURGERY, the publishers have found it necessary beginning with the July 1914 issue to enlarge the size of the page and also to somewhat reduce the size of type in which the original contributions have heretofore been printed. The enlarged size will also enable the publishers to make a better display of the illustrations which are such an important feature of the ANNALS OF SURGERY's contributions.

Thirty years ago, when the first number of the ANNALS OF SURGERY appeared, the size and style then shown suited admirably. At that time a single number contained only 96 pages. They have continued to increase each year until now the average number of pages to an issue is 164. Special issues have been published in which the number has been increased to over 300 pages, with the result that the manufacturing of the Journal in the former style is not only extremely difficult but the finished product is unwieldy and cannot be read with the ease and comfort which is due a subscriber. In fact, it required constant pressure on the pages to keep them open.

We believe the new form overcomes this inconvenience and enables us to give the reader more material and greater comfort while reading than it could have been possible for us to present in the former size.

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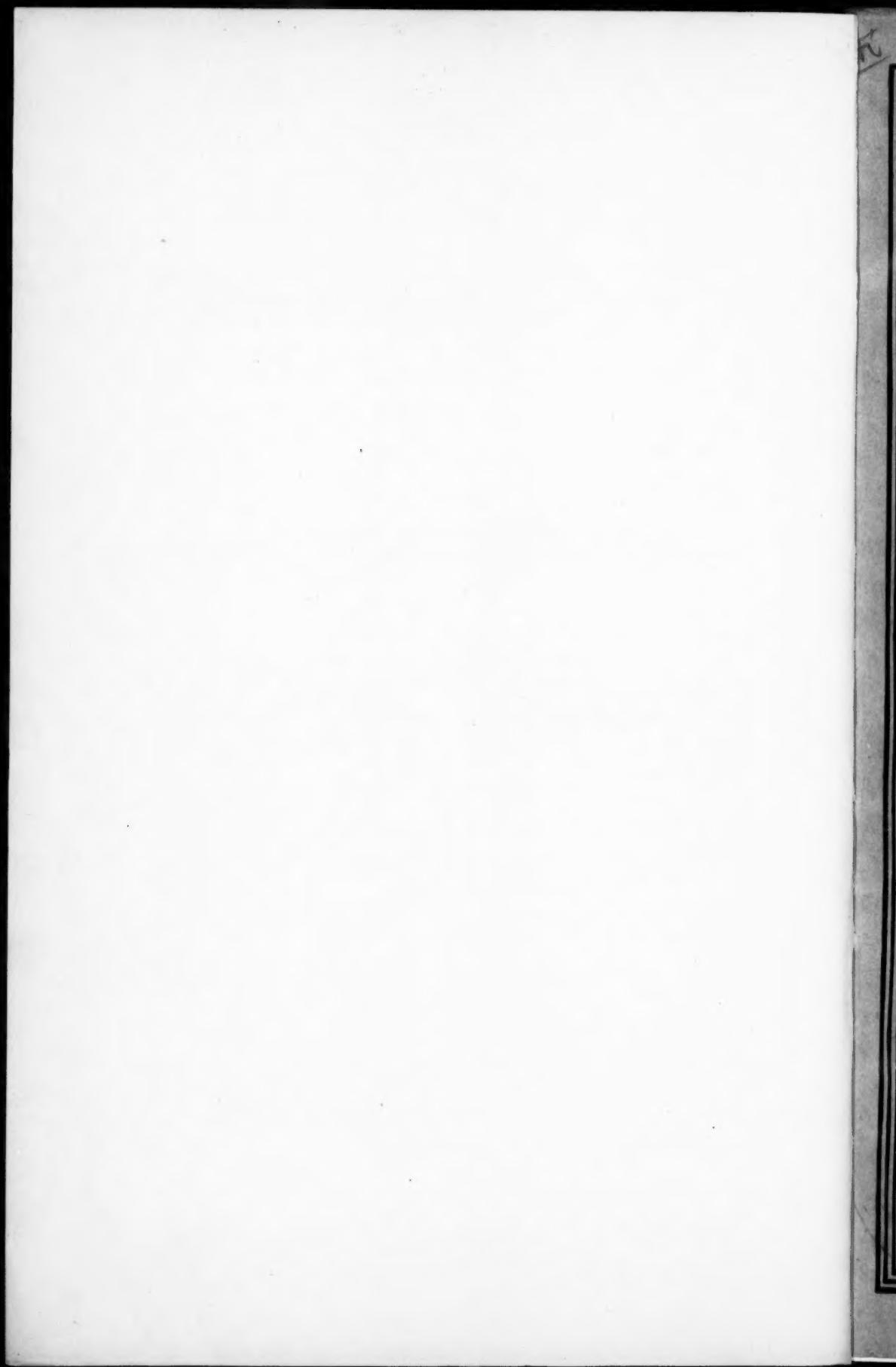
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A Monthly Review of Surgical Science and Practice.

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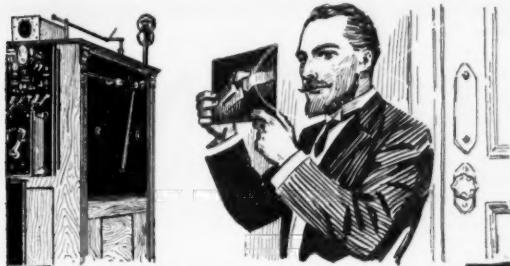
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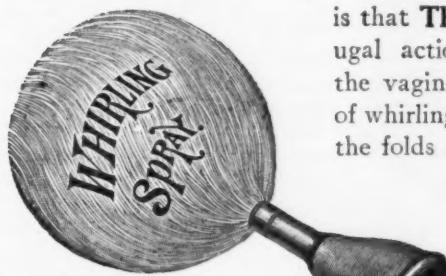
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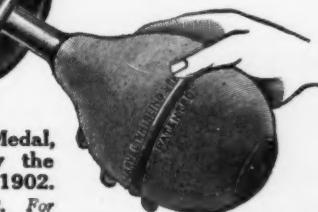


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That Selenium, an element of the sulphur group, possesses highly valuable therapeutic properties, especially with reference to malignant tumors, has been known for sometime past. Such far-famed investigators as Ehrlich, Wassermann and others, have demonstrated this beyond doubt. To von Oeefele we are indebted for first calling the attention of the American medical profession to the importance of this form of therapy and to the fact that certain cyanide derivatives of selenium are particularly endowed with the following characteristics of that element:

Remarkable pain-relieving action, closely rivalling that of morphine and other opiates, without the obvious dangers and drawbacks of the latter.

Marked systemic antiseptic, antiphlogistic and alterative properties, the latter probably due to its powerful oxidizing effect, which in carcinoma, etc., also causes transformation of the abnormally retained sulphur into soluble and readily excreted sulphates.

An empirically and clinically manifest, though histologically as yet not clearly defined, antagonistic action towards cancerous and pre-cancerous tissue.

Until recently, the therapeutic utilization of the above facts was much hampered by the great toxicity and irritant properties of these substances, rendering their administration by mouth, in adequately large and continuous doses, practically impossible, while the only alternative offered, viz: intravenous employment of colloidal selenium, eosin-selenium, etc., lacked the necessary simplicity for general use, not to speak of the already painfully recognized danger of intravenous medication under these conditions.

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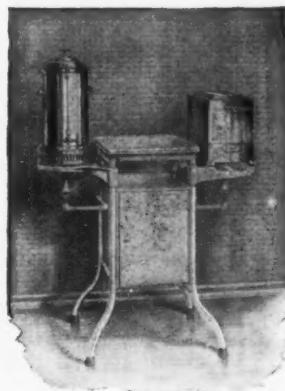
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Certain chronic conditions have been proven to be due to insufficiency of oxidizing ferment.

Chlorosis, for instance, is the result of the unsuccessful efforts of the oxydases to destroy the toxins due to constipation. Michel Duclos, of Tours, Dujardin-Beaumetz, Sir Andrew Clark and other eminent clinicians have established the fact that the destruction of red corpuscles in chlorotic subjects is due to auto-infection caused by constipation.

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THE DIFFERENCE.

By Harold Susman

The diff'rence 'twixt a "self-made man"

And "upstart" here I jot:
The first one is a friend of yours,
The second one is not.

NEEDED POSTING.

Oscar Underwood, of Alabama, leader of the House of Representatives, considers the following one of his best stories.

"Mrs. Underwood had been annoyed frequently by the colored cook's entertaining company in the kitchen," said Mr. Underwood, "and remonstrated with her, telling her that she must entertain her friends in her own quarters after working hours.

"Shortly after, Mrs. Underwood left the girl doing some work in the dining-room, and went to the kitchen on some errand. In the kitchen rocker sat a great, husky darky, eating a huge piece of pie. Very indignant, Mrs. Underwood hastened back to the dining-room.

"'Gerty,' she demanded, 'what have I told you about having your beau in the kitchen?'

"'Oh, Lor', miss,' replied Gerty, 'he ain't no beau! That coon ain't nuffin' but my brudder.'

"Somewhat mollified, Mrs. Underwood returned to the kitchen.

"'So you are Gerty's brother?' she inquired kindly.

"'Lor' bless yo', no, miss,' he said. 'I ain't no 'lation t'all to Gerty, I's jes' keepin' comp'ny wif her.'

"Mrs. Underwood, mighty angry, sought out Gerty again.

"'Gerty,' she said sternly, 'why did you tell me that man in the kitchen was your brother? He has just told me that he is no relation to you.'

"Gerty looked aghast. Then, turning in the direction of the kitchen, she said :

"'Fo' de Lawd's sake, Mis' Underwood, did that good-fur-nothin' thing say that? Jes' yo' stay here a minute an' lemme go look ag'in!'"

A. S. Hitchcock.

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"Indeed!"

"Oh, I don't mean to say," the fond mother hastened to explain "that I have ever really taken any summary action; but I have talked to him a great deal."

"And what have you said?"

"Why, I have said, 'Richard! Richard!' and other severe things."—Elgin Burroughs.

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